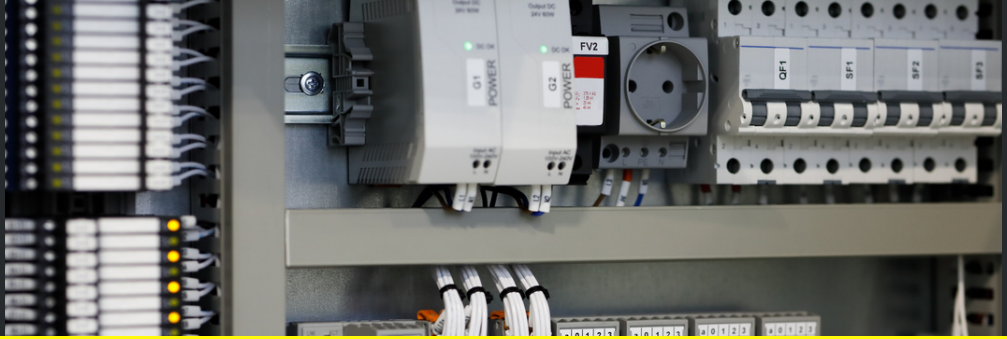
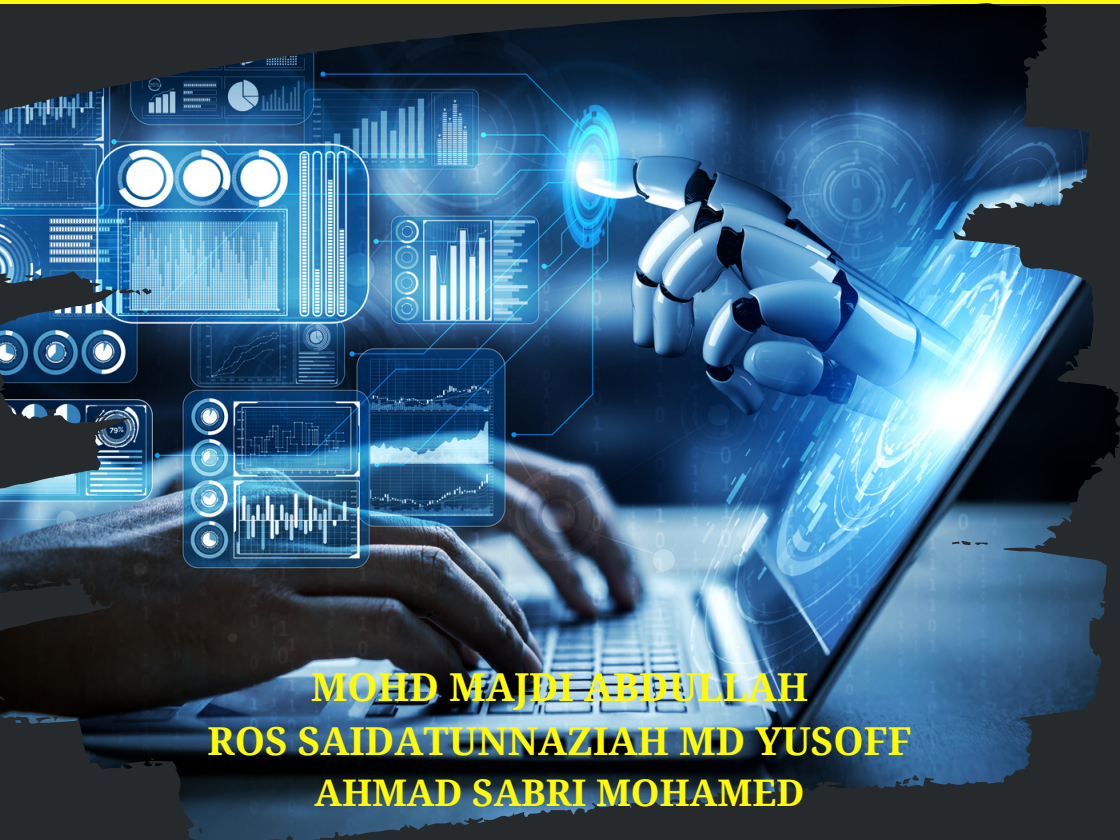


FAST AND EASY REVISION

PROGRAMMABLE LOGIC CONTROLLER



MOHD MAJDI ABDULLAH
ROS SAIDATUNNAZIAH MD YUSOFF
AHMAD SABRI MOHAMED

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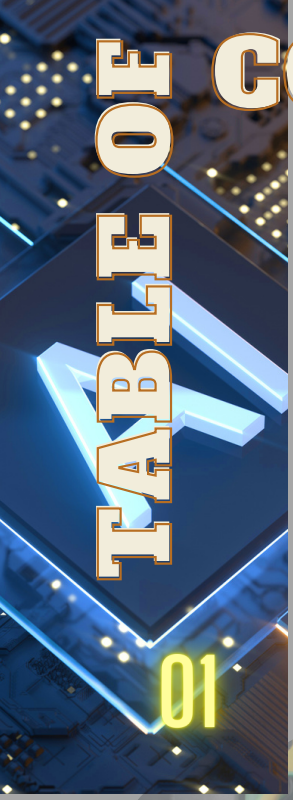
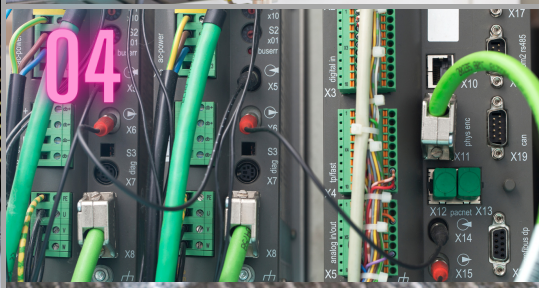
TABLE OF CONTENT





PREFACE

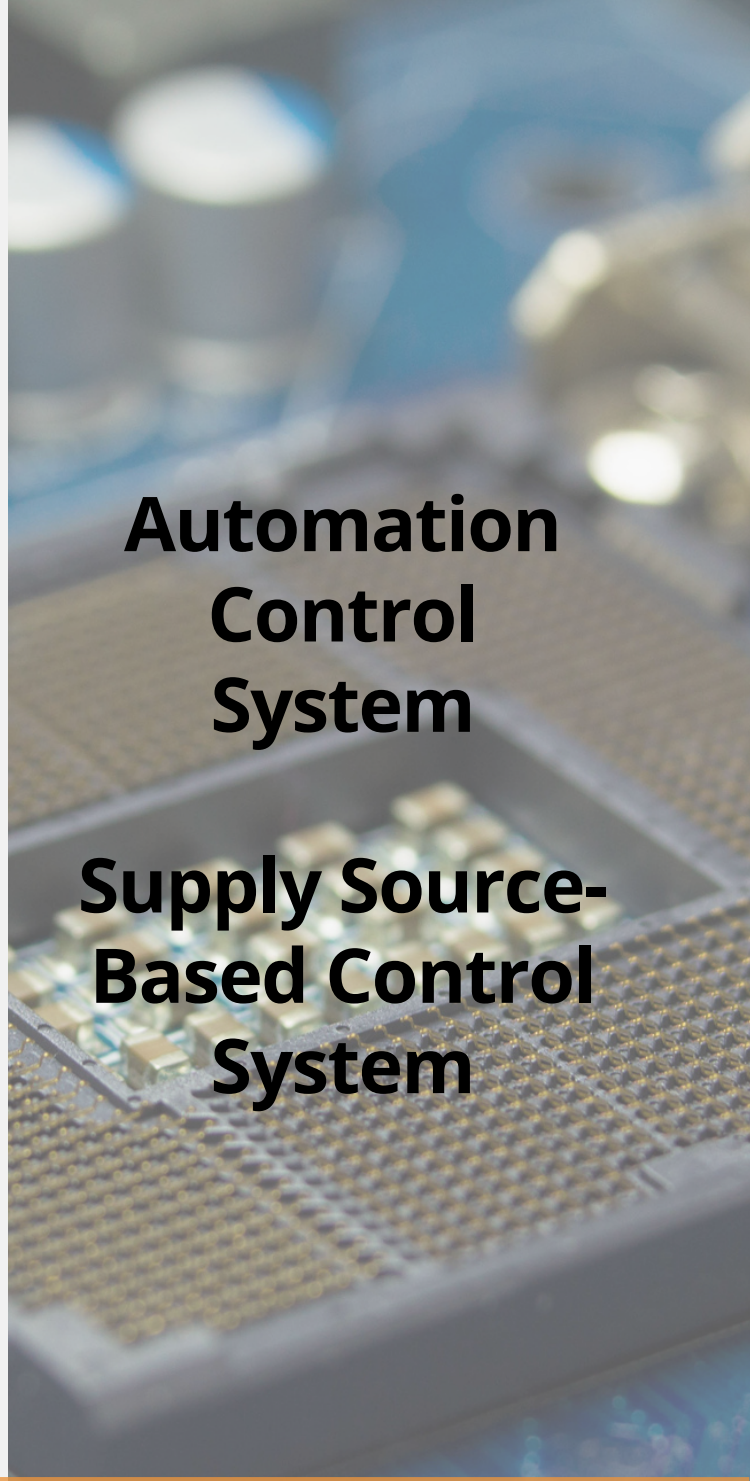
Deepest gratitude to Allah SWT because with His permission, this Fast and Easy Revision Programmable Logic Controller Book was successfully published. This book is published as a guide or reference for all students who follow engineering mechanical, mechatronic and electrical course. As an initial effort, the Fast and Easy Revision Programmable Logic Controller book was published alongside other controller guide books. We would like to express our deepest gratitude to all friends for the supported given to complete this book. Hopefully this Fast and Easy Revision Programmable Logic Controller book can be utilized to the best of its ability by all instructors and students.

THANK YOU

01

CONTROL SYSTEM

01 CONTROL SYSTEM



Automation Control System

Supply Source-Based Control System

Automation Control System

A system that is capable of controlling a process with minimal or non-human help and has the ability to initiate, adjust, display or measure variables in the process and discontinue the process in order to obtain the necessary output.

The main purpose of the Automation Control System used in the industry

a. Increase the quantity of output.
b. Improve the quality of the output.
c. Controlling the cost of expenses.

Classification Of Automation Control Systems

- ***Fixed Automation / Hard-Wire Control***

- specific task
- the function of its control circuit is fixed and permanent
- difficult to make changes / modifications

- ***Programmable Control System***

- complex control systems that
- can perform various tasks.
- its control circuit function is organized by the user and can be modified.
- easy to make changes / modifications

- ***Flexible Automation***

- Advanced from programmable Control System.
- Able to control different types of operations at a time

Figure 1.1: Flexible Automation

Comparison Between Fixed Automation and Programmable Automation

Table1: The comparison between fixed automation and programmable automation2

	FIXED AUTOMATION	PROGRAMMABLE AUTOMATION
Use	Specific	Various
Ease of making changes /improvements	Difficult	Easy
Maintenance	Easy	Difficult
Ability	Depends on the design and Manufacturing	Very high
Speed	Speed	Slow
Economic efficiency	Suitable for small systems	Suitable for all types of systems

Example:

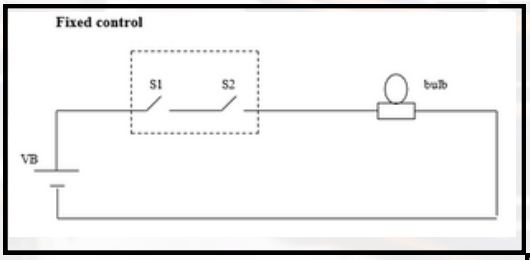


Figure 1.2: Fixed Control

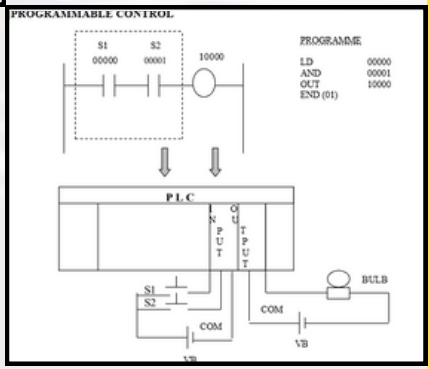


Figure 1.3: Programmable Control

Supply Source-Based Control System

 # Pneumatic Control System

 # Hydraulic Control System

 # Electrical Control System

Pneumatic Control System

This pneumatic control system can be controlled in a humane and automatic manner.
The pneumatic system requires:

- **Compressed air supply**
- **Control valve**
- **Connecting tube**
- **Transducer**

Basic Block Diagram of Pneumatic Control System

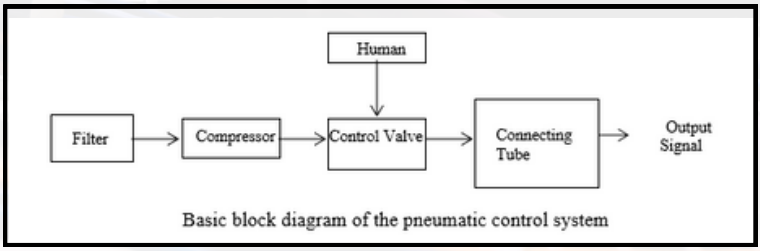


Figure 1.4: Basic block diagram of the pneumatic control system

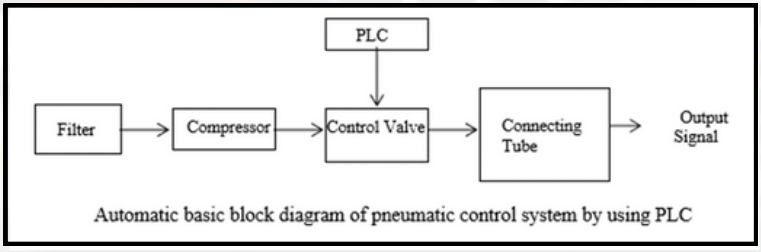


Figure 1.5: Automatic basic block diagram of pneumatic control system by using PLC

Hydraulic Control System

Hydraulic system requires :

- **Hydraulic fluid supply**
- **Control valve**
- **Cylinder**

Hydraulic control system block Diagram

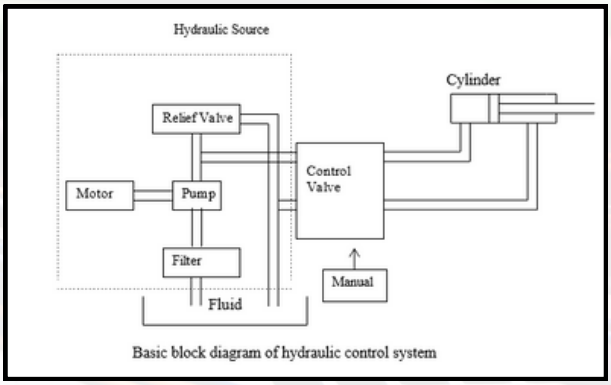


Figure 1.6: Basic block diagram of hydraulic control system

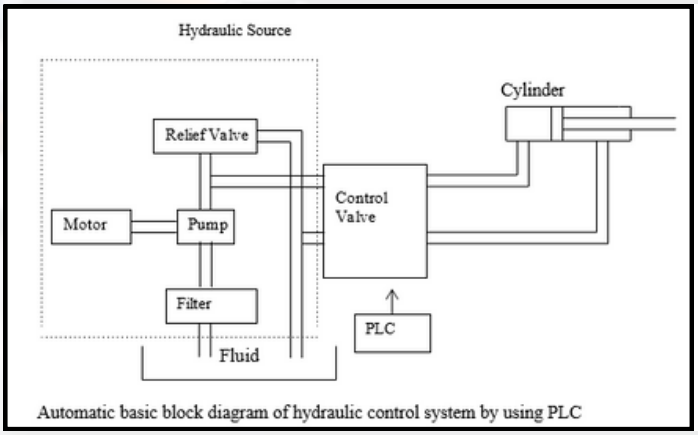


Figure 1.7: Automatic basic block of hydraulic control system by usinng PLC

Electrical Control System

The Electrical Control System requires:

- **Electricity supply (Ac) or (Dc)**
- **Input elements**
- **Output elements**
- **Connecting cable**

Electrical control system block Diagram

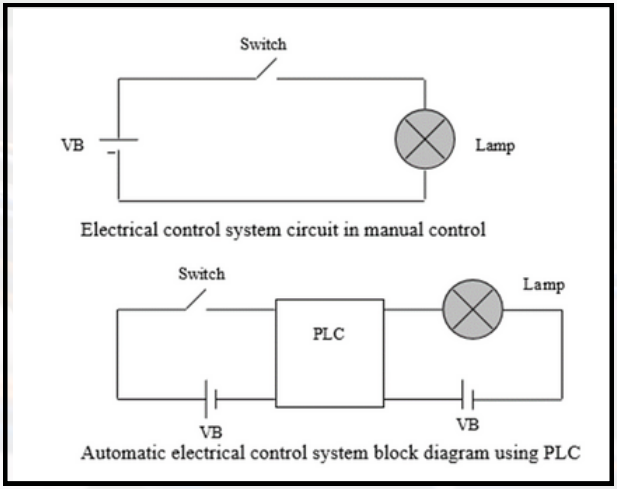


Figure 1.8: Automatic electrical control system block diagram using PLC

Comparison Between Pneumatic Control System, Hydraulic Control System And Electrical Control System

Pneumatic control system

- The installation system is simple.
- The system design is simple.
- Use compressed air as a source of supplies to do the work.

Hydraulic control system

- The installation system is complicated.
- Using fluid such as oil as a source of supply to do the work.
- In case of leakage will cause impurities/pollution.

Electrical control system

- Simple system.
- Using electricity as a source of supply to do the work.
- Its use is widespread.

Control System

he basic components of the control system can be divided into five parts:

- **Reference signal generator (entry/set point)/ input signal)**
- **Measurement element.**
- **Comparison.**
- **Controller.**
- **The actuator.**
- **Controlled system**

OPEN LOOP CONTROL SYSTEM

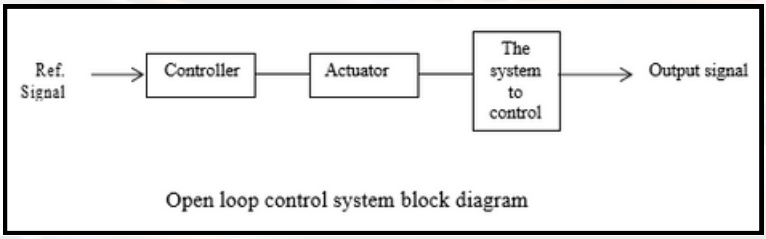


Figure 1.9: Open loop control system block diagram

CLOSE LOOP CONTROL SYSTEM

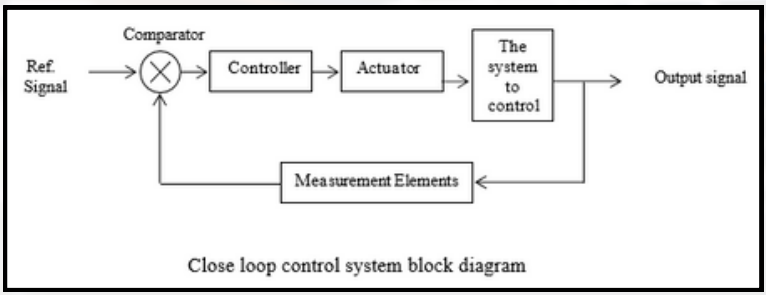


Figure 1.10: Close loop control system block system

COMPUTERIZED CONTROL SYSTEM

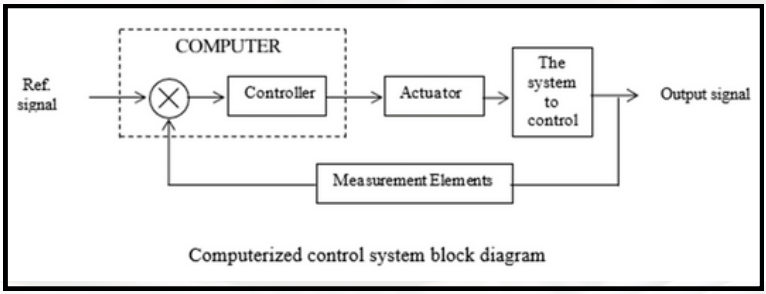


Figure 1.11: Computerized control system block diagram

Example: Street lamps

Situation 1:

The lights will turn on at a certain time (7 p.m.) and then turn off the next day (8 a.m.).

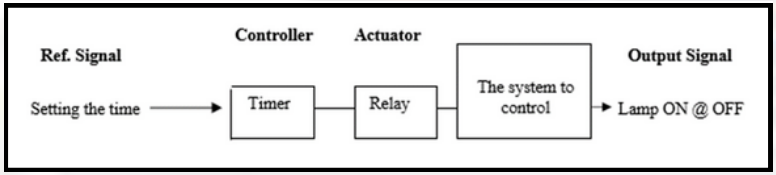


Figure 1.12: Timer and relay

Situation 2:
The lights will turn on on on their own when it is dark and turn off on its own when the conditions are sunny.

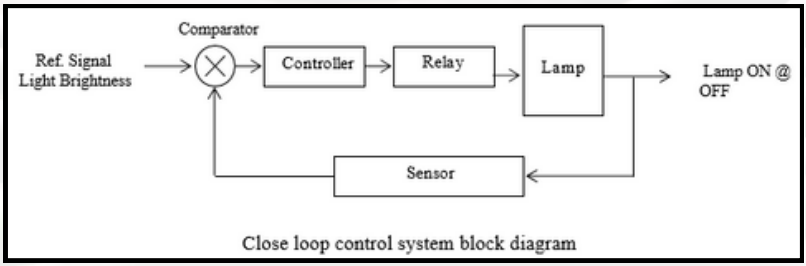


Figure 1.13: Close loop control system block diagram

Comparison Between Open Loop System And Closed Loop System

Open Loop System

- The build is simple.
- Precision depends on the calibration of the elements.
- Not so suffering from instability.
- Unable to reduce the effect of intransigence (ketidaklurusan).

Close Loop System

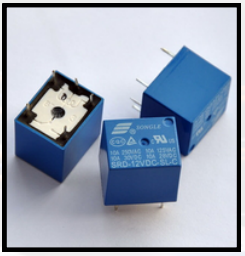
- The build is complicated.
- The system is very effective.
- Having a problem with instability.
- The effect of intransigence (ketidaklurusan) can be reduced.

Relay

What is relay?

- **The relay is the device that open or closes the contacts to cause the operation of the other electric control.**

- **It detects the intolerable or undesirable condition with an assigned area and gives the commands to the circuit breaker to disconnect the affected area. Thus protects the system from damage.**



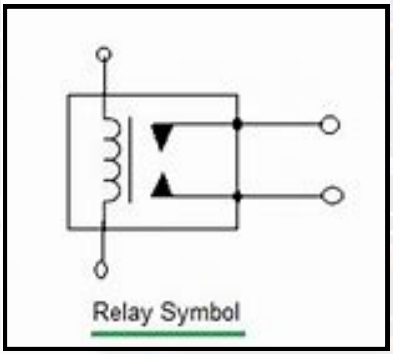
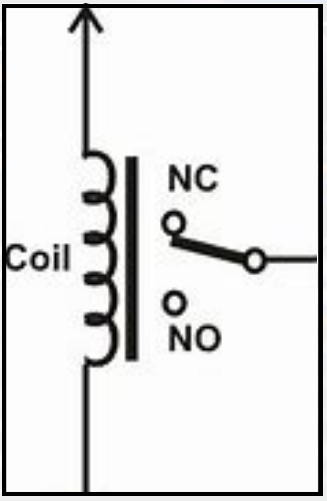


Figure 1.14: Relay symbol



Relay

Working Principle of Relay

- **It works on the principle of an electromagnetic attraction.**

- **When the circuit of the relay senses the fault current, it energises the electromagnetic field which produces the temporary magnetic field.**

- **This magnetic field moves the relay armature for opening or closing the connections.**

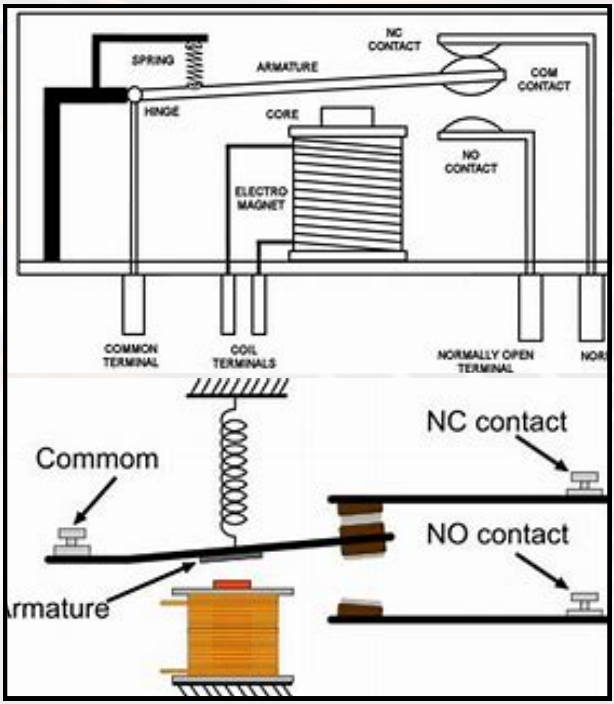


Figure 1.15: Working princple relay

Relay

Relay types

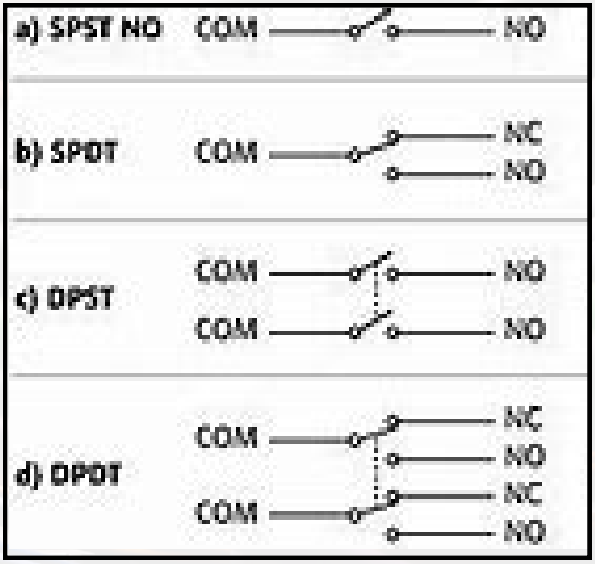


Figure 1.16

Contactor

A contactor is a relay that is used for switching power. It usually handle very heavy loads like an electric motor, lighting and heating equipment.

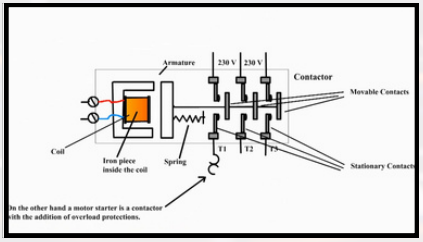


Figure 1.17: Contactor

Contactors are controlled by a circuit with very less power even though their output is used for switching very high loads.

Contactor symbol

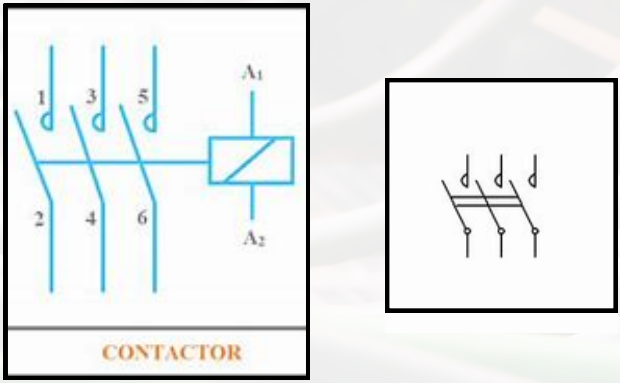


Figure 1.18: Contractor symbol

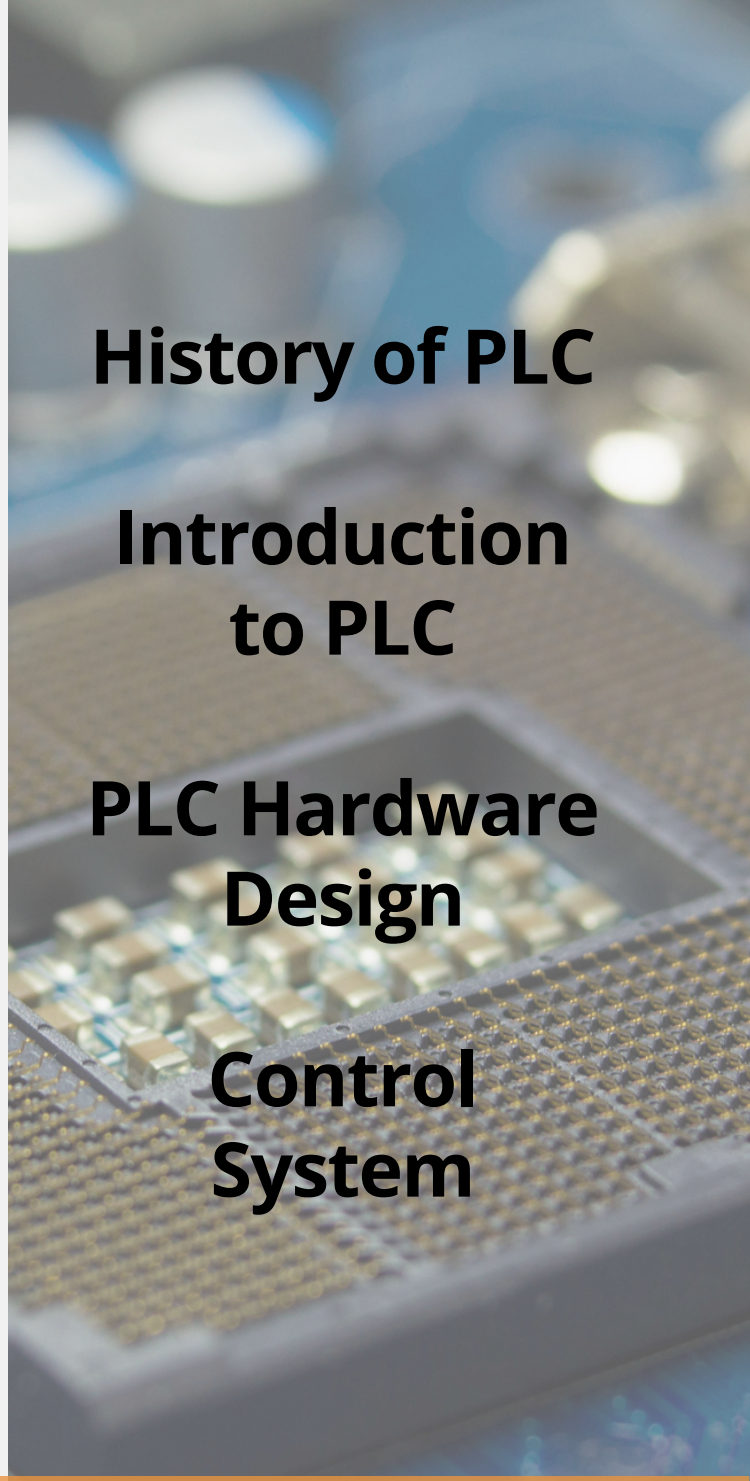
Different between relay & contactor

Relays and Contactors are electromagnetic switches. The only difference is that relays are usually used for low voltage applications while contactors are used for higher voltage application.

02

WHAT IS PLC

02 WHAT IS PLC



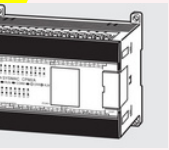
History of PLC

Introduction to PLC

PLC Hardware Design

Control System

INTRODUCTION TO PROGRAMMABLE LOGIC CONTROLLER



WHAT IS PLC

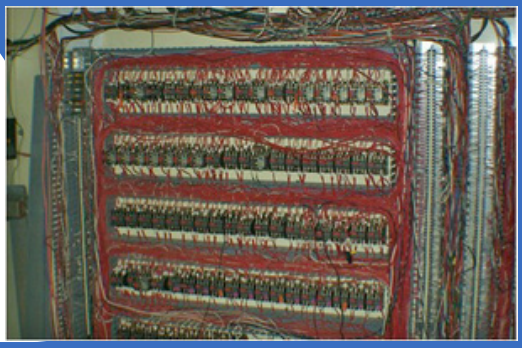
PROGRAMMABLE LOGIC CONTROLLER (PLC):

A digital electronic device that uses a programmable memory to store instructions and to implement specific functions such as logic, sequence, timing, counting and arithmetic to control machines and process

National Electrical Manufacturers Association of America (NEMA)

" Satu sistem elektronik beroperasi digital yang digunakan di dalam persekitaran industri, yang mana menggunakan ingatan yang boleh diaturcara untuk simpanan dalaman ke atas arahan-arahan untuk melaksanakan fungsi tertentu seperti logik, turutan, pemasaan, pembilang dan pengiraan matematik untuk mengawal berbagai mesin atau proses melalui modul masukan dan keluaran digital ataupun analog"

HISTORY AND SPESIFICATIONS OF PLC



HISTORY HISTORY OF PLC

FIRST

- During the late 1960s, General Motors (USA) was interested in the computer application to replace the hardwire systems.

SECOND

- Bedford Associates (Modicon) and Allen Bradley responded to General Motors.
- The name given was “Programmable Controllers” or PC.
- Later, PC was used for “Personal Computer” and to avoid confusion PLC for “Programmable Controller” and PC for a personal computer.

THIRD

Programmable Logic Controller or PLC was a registered trademark of the Allen Bradley.

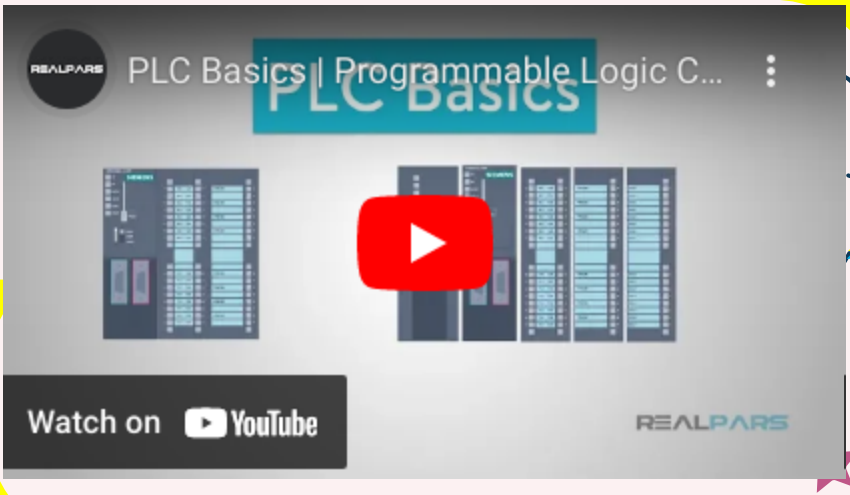
SPESIFICATIONS OF PLC

- Easy to program
- No need to reinstallation over the control system in case of changes to the program
- Smaller, cheap and high reliability.
- Its simple and cheap maintenance.
- Competitive costs.

INTRODUCTION TO PROGRAMMABLE LOGIC CONTROLLER (VIDEO)

VIDEO 1:

VIDEO 2: https://www.youtube.com/watch?v=PbAGl_mv5XI



PLC TYPES

TYPES OF PLC AND THE BRAND USED IN INDUSTRY

TYPE 1 : COMPACT PLC

COMPACT PLC -In I/O capability is fixed and determined by the manufacturer. They are used for small scale uses.

A single case contains the multiple built-in modules. The integral PLC has integrated power supply, CPU, I/O interfaces and other components are housed in a compact chassis. Some of the integrated PLCs allow connecting additional I/Os.

Figure 2.1: Compact PLC

TYPE 2: MODULAR PLC

built with several components that are plugged into a common rack or bus with extendable I/O capabilities. It contains power supply module, CPU and other I/O modules that are plugged together in the same rack, which are from same manufacturers or from other manufacturers. These modular PLCs come in different sizes with variable power supply, computing capabilities, I/O connectivity, etc.

Figure 2.2: Modular PLC

PLC TYPES

TYPES OF PLC AND THE BRAND USED IN INDUSTRY

TYPES 3:
PLUG IN CARDS PLC

- Available for additional I/O, communications, backup memory and specialty capabilities
- Snaps easily into controller without expanding the footprint
- Operates in -20…+65 °C (-4…+149 °F) temperatures

Figure 2.3: Plug in Cards PLC

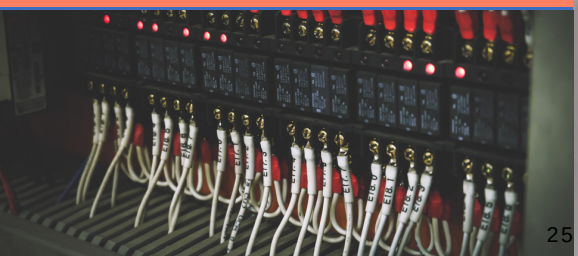
USUAL USED IN INDUSTRY

JAPAN

- Omron
- Mitsubishi
- Nais
- Toshiba
- NEC
- Alan Bradly

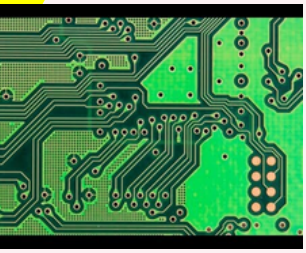
AMERICA

- Festo
- Siemens
- Keysence



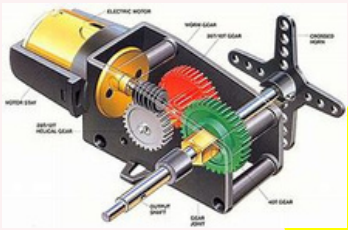
PROGRAMMABLE LOGIC CONTROLLER

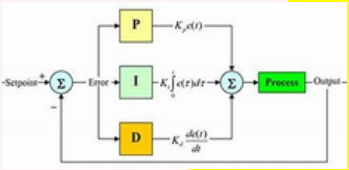
FUNCTION



- **Sequential Control**
- Timer
- Counter
- Replacement of the printed circuit board control card
  Machine controllers and processes for automatic, semi-automatic and Manual control

- **Advanced Controls**
- Completing mathematical operations
  (+, -, ¸, x)
- Servo Motor Control
- Stepper Motor Control
- P.I. D Control
  (Propotional – Integral – Derivation)





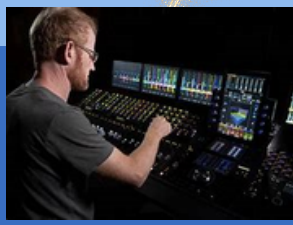
- **Supervisory Control**

- ASCII code
- Local Area Network (LAN)
- Wide Area Network (WAN)

PROGRAMMABLE LOGIC CONTROLLER

ADVANTAGES OF PLC COMPARED TO HARDWIRE

- Implementing changes and correcting errors
- Pilot run - trial / test run
- Visual observation - online monitoring
- Speed of operation
- High Reliability
- Documentation
- Resistance to environmental problems (temperature, moisture, voltage instability and noise).
- The implementation period of a short control project.
- Accurate project cost calculation.
- control system is changed using the software.
- Extensive control applications
- Easy Maintenance
- Standard controller hardware.



BASIC MICROCOMPUTER DESIGN

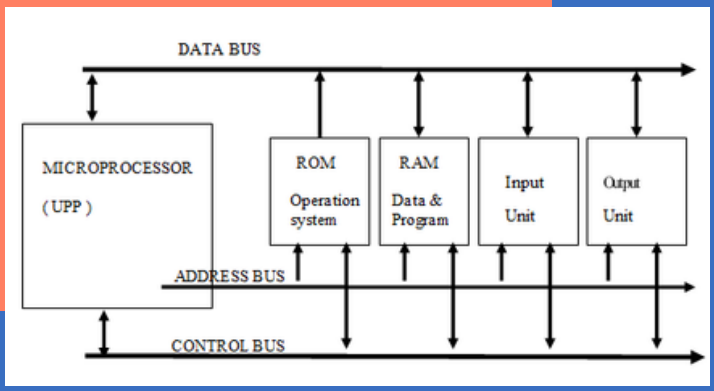


Figure 2.4: Basic microcomputer design

PROGRAMMABLE LOGIC CONTROLLER
HARDWARE DESIGN

CENTRAL PROCESSING UNIT

1. **This unit is the most important unit in the construction of a PLC.**
2. **In this unit is a chip-in-line, a microprocessor chip that controls the entire process of PLC control operations.**
3. **The microprocessor contains Arithmatics units, control units and some number of memory units known as registers.**

MEMORY UNIT

This Unit consists of TWO (2) Types of memory:

1. **RAM (RANDOM ACCESS MEMORY)**

- RAM is a type of memory read/write and easy to programmed and improve.
- All user programs are stored in this memory. This program will be lost when power supply is disconnected .

2. **ROM (READ ONLY MEMORY)**

- ROM is a read-only type memory. The system program is stored in this memory. This program will not be lost when power supply is disconnected.

PROGRAMMABLE LOGIC CONTROLLER
HARDWARE DESIGN

UNIT INPUT DAN OUTPUT

a. **The unit where the input device (switch, sensor) is connected to it.**
b. **The units for the output device (light, motor) are connected to it.**

DISPLAY AND INDICATOR UNIT

a. **The display and indicator Unit refers to the state view of the PLC's internal relay status.**
b. **This can be seen in the programming console if the user uses the programming method mnemonic and the computer screen if the user uses the software programming method**

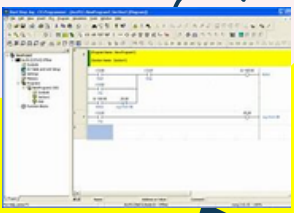
HOUSING UNIT

This Unit provides protection to circuits and the internal components of PLC.

PROGRAMMING UNIT

The programming Unit of PLC consists of two devices namely:

- **Console programming.**
- **Computer.**



PROGRAMMABLE LOGIC CONTROLLER
HARDWARE DESIGN

SECONDARY STORAGE UNIT

- This Unit is related to the central processing Unit where all programs and information are stored.

UNIT VDU (Display Video Unit)

- The Unit which processes operational information and system status will be displayed by PLC.

POWER SUPPLY UNIT

- The Unit provides the power to central processing Unit, Input Unit and Output Unit.

PRINTER UNITS

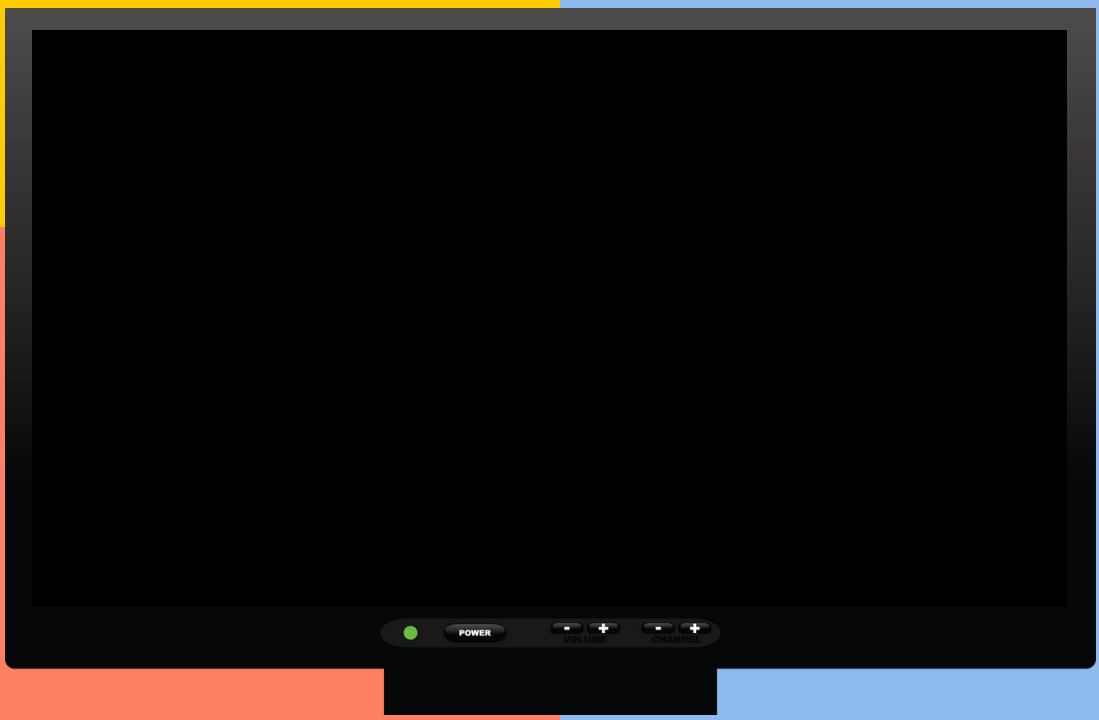
- This Unit is used to print the program of a control system controlled by PLC either in graphics or text.

VIDEO APPLICATION OF PLC

BASIC STRUCTURE OF A PLC

INPUT CONNECTIONS

INPUT MODULES



OUTPUT CONNECTIONS

OUTPUT MODULES

WHAT IS A CONTROL SYSTEM?

A control system is a system that controls or manages the behavior of other systems or processes. It receives inputs and produces outputs, and includes sensors, actuators, controllers, and feedback loops. The goal of a control system is to maintain the desired performance of a system or process by monitoring its inputs and outputs, and adjusting as needed. There are different types of control systems, such as open-loop, closed-loop, feedback, and feedforward control systems, which are used depending on the application and desired performance criteria.

Control System

Control systems can be classified into different types based on their characteristics and operation. Some common types of control systems are:

OPEN LOOP CONTROL SYSTEMS

CLOSED LOOP CONTROL SYSTEMS

FEEDBACKCONTROL SYSTEMS

FEEDFORWARD CONTROL SYSTEMS

Open-loop control systems: *These control systems operate without feedback and rely on a predefined set of instructions or inputs to produce the desired output. They are simple but not very accurate, and their performance is affected by changes in the system or environment.*

Closed-loop control systems: *These control systems use feedback to compare the output of the system or process being controlled with the desired output, and adjust minimize the error. They are more accurate and reliable than open-loop systems, but also more complex and expensive.*

Feedback control systems: *These control systems use sensors to measure the output of the system or process being controlled and provide feedback to the controller, which adjusts the input to maintain the desired output. Feedback control systems can be either open-loop or closed-loop.*

Feedforward control systems: *These control systems use a predictive model of the system or process being controlled to anticipate changes and adjust the input to minimize the error. They are often used in systems that are highly dynamic and require fast response times.*

Control System

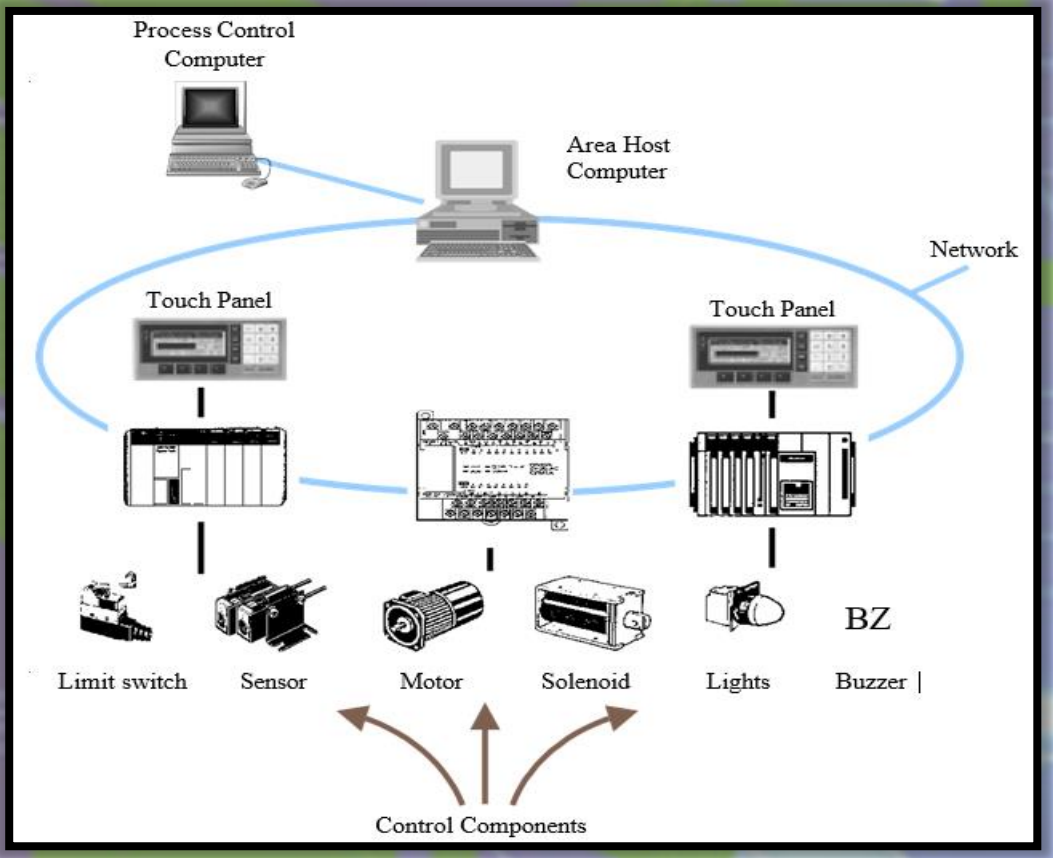


Figure 3.1: Control System

In summary, a control system is a system that regulates the behavior of other systems or processes by receiving inputs, processing them using controllers and feedback loops, and producing outputs to adjust the behavior of the system or process being controlled. Control systems are used in various applications and can be classified based on their characteristics and control objectives.

Microprocessor Controlled System

In a microprocessor-controlled system, the microprocessor communicates with other components of the system, such as sensors, actuators, and memory devices, through input/output interfaces. The microprocessor reads data from sensors, processes it, and sends signals to actuators to control their operation. It also stores data in memory devices and retrieves it when needed.

A microprocessor-controlled system is a system that uses a microprocessor as its central processing unit (CPU) to control its operations. A microprocessor is a small computer chip that contains a CPU, memory, and input/output interfaces on a single integrated circuit. It is capable of executing a set of instructions and performing arithmetic and logical operations.

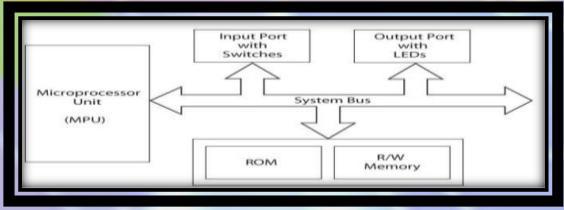


Figure 3.2: Microprocessor Controlled System

Microprocessor-controlled systems are used in a wide range of applications, such as automation, robotics, telecommunications, medical devices, and consumer electronics. They offer many advantages, such as high-speed processing, flexibility, and the ability to perform complex operations. They can also be programmed and reprogrammed to adapt to changing requirements or to add new features.

Programmable Logic Controller

A PLC is a microprocessor-based controller that controls machines and processes. It uses programmable memory to store instructions and perform functions such as logic, sequencing, timing, counting, and arithmetic. PLCs are designed to be used by engineers with limited knowledge of computing languages. The control program can be entered using a simple and intuitive language. Input devices such as sensors and output devices like motors and valves are connected to the PLC. The operator enters a program sequence into the memory of the PLC, which monitors inputs and outputs according to the program and executes the programmed control rules.

Figure 3.3: Programmable Logic Controller

PLCs offer the advantage of being able to use the same basic controller with a wide range of control systems. To modify a control system, an operator only needs to key in a different set of instructions, without the need for rewiring. This results in a flexible and cost-effective system that can be used with control systems that vary widely in their nature and complexity. Although similar to computers, PLCs are optimized for control tasks and the industrial environment, rather than for calculation and display tasks.

Input Devices

Intelligence of an automated system is greatly depending on the ability of a PLC to read in the signal from various types of automatic sensing and manual input field devices.

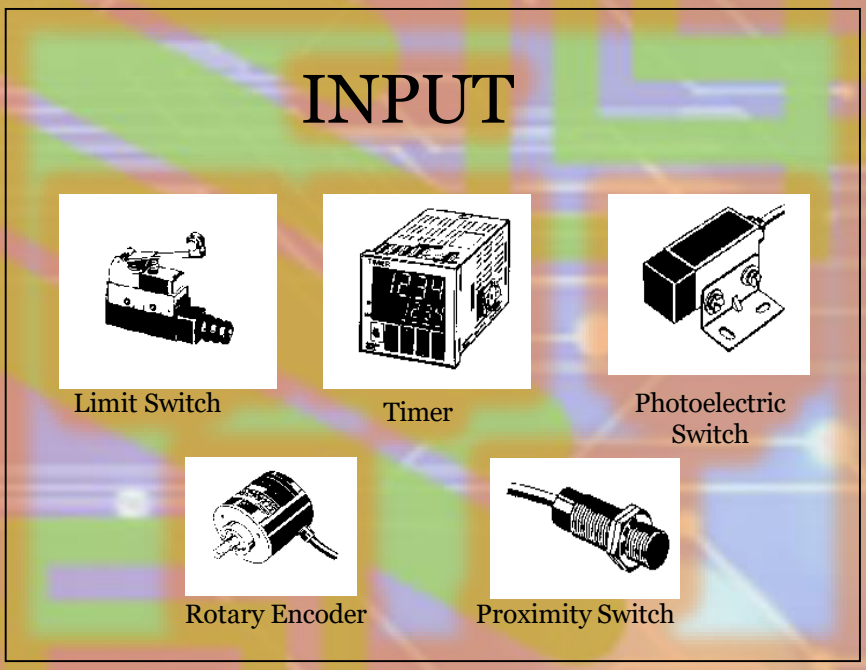


Figure 2.1: Input Device

Push-buttons, keypad and toggle switches are examples of manual input devices that form the basic man-machine interface for a PLC. These devices are used for human input into the PLC and are essential for the operator to provide instructions and commands to the controller.

Input Devices

In addition to manual input devices, the PLC needs to detect workpieces, monitor moving mechanisms, check pressure or liquid levels, and perform many other functions. The PLC taps signals from specific automatic sensing devices like proximity switches, limit switches, photoelectric sensors, and level sensors to perform these tasks. These sensing devices provide input signals to the PLC, which can be either ON/OFF logic or analogue.

The PLC input module is responsible for interfacingmodule processes the signals and converts them into a format that the PLC can understand, allowing the controller to carry out the necessary control and automation func the various input signals to the PLC. There are different types of PLC input modules available depending on the type of input signal and interface required. The input tions.

Output Devices

Automated systems have revolutionized the way industrial processes are carried out, allowing for increased precision, efficiency, and productivity. One of the key components of an automated system is the output devices, which serve as the interface between the system and the physical world. These devices include motors, solenoids, indicators, buzzers, and alarms, among others, and a crucial role in controlling and monitoring various aspects of the system.

Output Devices

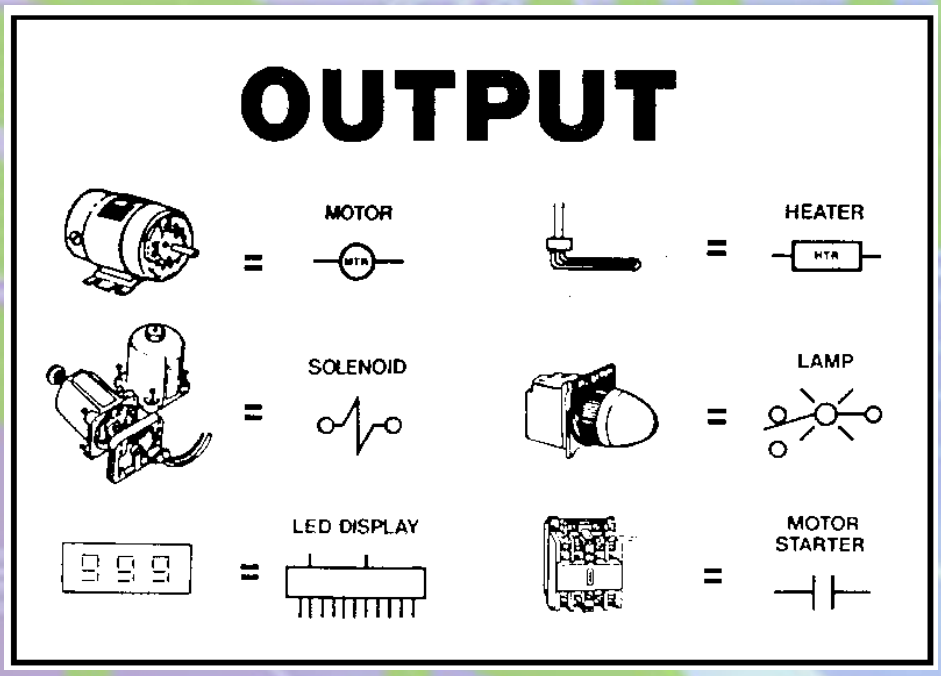


Figure 2.1: Output Device

Motors and solenoids are among the most commonly used output devices in automated systems, as they provide the necessary force and motion to control different types of machinery and equipment. For example, a pick and place system might use motors to move components from one location to another, while a servo positioning system might use solenoids to precisely control the position of a component.

Indicators, buzzers, and alarms, on the other hand, are typically used for notification purposes, alerting operators or maintenance personnel of any issues or events that require attention. For example, a pilot lamp might indicate the status of a machine, while a buzzer might signal an alarm if a certain condition is met, such as low fluid level or high temperature.

To interface these output devices with the programmable logic controller (PLC), a range of PLC output modules are available. These modules provide different types of outputs, such as digital, analog, or pulse signals, depending on the specific requirements of the system. For example, a digital output module might be used to control a motor, while an analog output module might be used to control the speed of a conveyor belt.

Proper interfacing of output devices with the PLC is critical to ensure the overall performance and efficiency of the automated system. Any issues with the output devices can result in malfunctions or errors in the system, which can lead to downtime and lost productivity. Therefore, it is important to choose the right output devices and output modules for the system, and to ensure they are properly integrated and tested before operation.

Control System

A programmable logic controller (PLC) is an industrial control system that uses a microprocessor-based architecture to perform control functions. The basic block diagram of a typical PLC includes the following components:

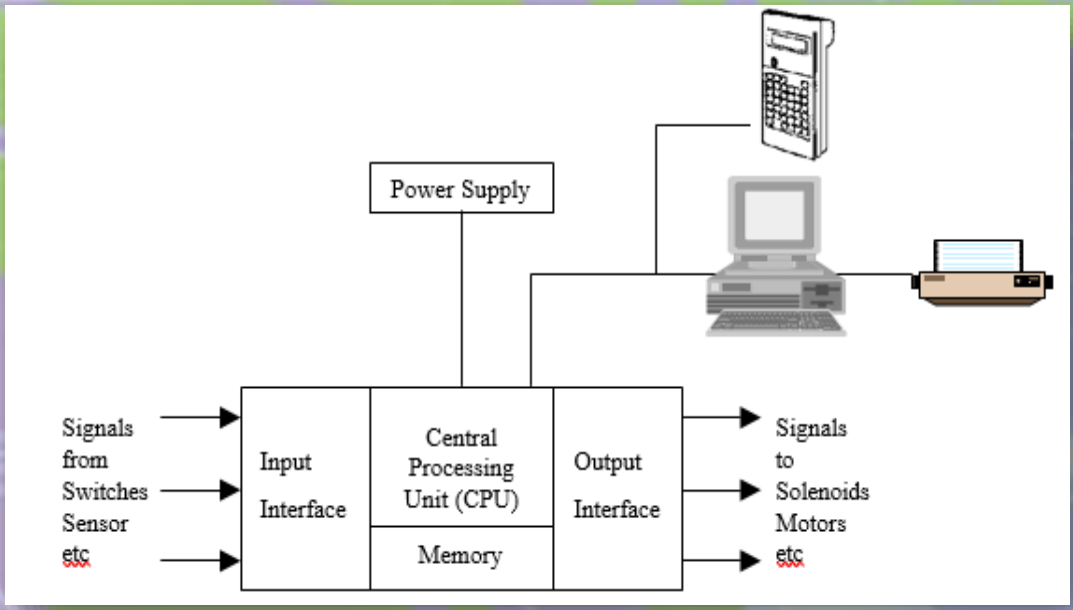


Figure 2.1: Input Device

Input Module: This module is responsible for interfacing the PLC with the input devices, such as sensors, switches, and transmitters. It converts the signals received from these devices into digital signals that can be processed by the PLC's microprocessor.

Control System

CPU: The CPU is the central processing unit of the PLC and is responsible for executing the control program stored in the memory. It performs the arithmetic and logical operations required to control the system based on the inputs received.

Memory: There are various types of memory unit. It is the area that hold the operating system and user memory. The operating system is actually a system software that co-ordinates the PLC. Ladder program, Timer and Counter Values are stored in the user memory. Depending on user's need, various types of memory are available for choice:

- **Read -Only Memory (ROM)**

  ROM is a non-volatile memory that can be programmed only once. It is therefore unsuitable. It is least popular as compared with others memory type.

- **Random Access Memory (RAM)**

  RAM is commonly used memory type for storing the user program and data. The data in the volatile RAM would normally be lost if the power source is removed. However, this problem is solved by backing up the RAM with a battery.

- **Erasable Programmable Read Only Memory (EPROM)**

  EPROM holds data permanently just like ROM. It dose not require battery backup. However, its content can be erased by exposing it to ultraviolet light. A prom writer is required to reprogram the memory.

- **Electrically Erasable Programmable Read Only Memory (EEPROM)**

  EEPROM combines the access flexibility of RAM and the non-volatility of EPROM in one. Its contents can be erased and reprogrammed electrically, however, to a limit number of times.

- **Flash Memory**

  Flash memory is a type of non-volatile memory that can be electrically erased and reprogrammed. It is commonly used in PLCs to store the user program and data. Flash memory offers a higher degree of reliability and endurance than other types of memory, and can be erased and reprogrammed multiple times without the need for a separate erase cycle.

- **Magnetic Disk Memory**

  Magnetic disk memory is a type of non-volatile memory that is commonly used for storing large amounts of data, such as historical data or system logs. It consists of a rotating disk coated with a magnetic material, and read/write heads that can access the data stored on the disk. Magnetic disk memory has a higher storage capacity than other types of memory, but is slower and less reliable.

Figure 2.4: Input Device

- **Solid-State Drive (SSD)**

  SSD is a type of non-volatile memory that is commonly used in industrial automation systems. It uses NAND flash memory to store data and offers higher performance, reliability, and durability than magnetic disk memory. SSDs are commonly used for storing the operating system and user data in a PLC system.

Output Module: The output module is responsible for interfacing the PLC with the output devices, such as motors, solenoids, and actuators. It converts the digital signals from the CPU into analog or digital signals that can be used to control the output devices.

Communication Module: The communication module enables the PLC to communicate with other devices in the system, such as a supervisory control and data acquisition (SCADA) system or a human-machine interface (HMI). It supports various communication protocols, such as Ethernet, Modbus, and Profibus.

Power Supply: The power supply provides the necessary power to operate the PLC and its components. It typically includes a transformer, rectifier, and filter circuitry to convert the incoming AC voltage to DC voltage.

In summary, a typical PLC block diagram includes input modules, CPU, memory, output modules, communication modules, and power supply. These components work together to perform control functions in an industrial automation system.

PLC vs. Conventional Control Panel

Before the 1960s and 1970s, industrial machines were controlled by large control panels filled with electromechanical relays. These relays were hardwired together, making it difficult to troubleshoot and modify the system. The control panels were massive, taking up entire walls, and were inflexible - they could only be used for one specific process and could not be easily changed to a new system.

Modifications to the control panel required stopping the machine, tracing the wiring, and making changes to the connections. Electricians had to be highly skilled and trained in order to maintain and troubleshoot these systems. Additionally, the relays had limited contacts, which further limited their functionality. All of these factors combined made the conventional relay control panels time-consuming and difficult to work with. However, with the introduction of the programmable logic controller (PLC), industrial automation became more efficient and flexible.

Table 1.1: PLC vs. Conventional Control Panel

Programmable Logic Controller (PLC)	*Conventional Control Panel*
The wiring of the system usually reduces by 80% compared to conventional relay control system.	There are too many wirings works in the panel.
The power consumption is greatly reduced as PLC consume much less power.	Modification can be quite difficult.
The PLC self-diagnostic functions enable easy and fast troubleshooting of the system.	Troubleshooting can be quite troublesome as you may require a skillful person.
Modification of control sequence or application can easily be done by programming through the console or computer software without changing of I/O wiring, if no additional Input or Output devices are required.	Power consumption can be quite high as the coil consumes power.
In PLC System spare parts for relays and hardware timers are greatly reduced as compared to conventional control panel.	Machine downtime is usually long when problems occur, as it takes a longer time to troubleshoot the control panel.
The machine cycle time is improved tremendously due to the speed of PLC operation is a matter of milliseconds. Thus, productivity increases.	Drawings are not updated over the years due to changes. It causes longer downtime in maintenance and modification.
It cost much less compared to conventional system in situation when the number of I/O is very large and control functions are complex.	There are too many wirings works in the panel.
It cost much less compared to conventional system in situation when the number of I/Os is very large and control functions are complex.	
The reliability of the PLC is higher than the mechanical relays and timers.	
An immediate printout of the PLC program can be done in minutes. Therefore, hardcopy of documentation can be easily maintained	

03

PROGRAMMING LANGUAGE

03 PROGRAMMING LANGUAGE

Ladder Diagram

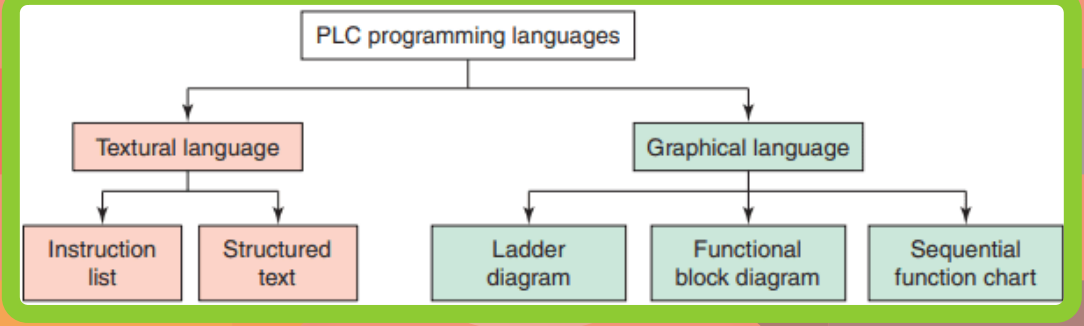
Instruction List

Structured Text

Sequential Function Chart

Function Block Diagram

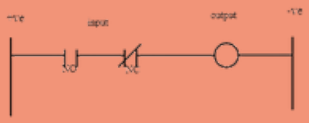
PROGRAMMING LANGUAGE



There are FIVE internationally recognized programming languages:

- *Ladder Diagram*
- *Instruction List*
- *Structured Text*
- *Sequential Function Chart*
- *Function Block Diagram*

Ladder Diagram



A ladder diagram is a graphic-type programming language converted from a relay control wiring circuit diagram. The ladder diagram contains a touch track from the left to the right of the diagram.

The contactor is connected to a normally open – NO or normally closed – NC through the passage of currents and element loops. The ladder diagram also shows the control circuit and displays the functions and combinations of sequential operations for each branch on a horizontal row separately.

Ladder diagrams (sometimes called "ladder logic") are a type of electrical notation and symbology frequently used to illustrate how electromechanical switches and relays are interconnected. The two vertical lines are called "rails" and attach to opposite poles of a power supply, usually 120 volts AC.

Ladder logic has evolved into a programming language that represents a program by a graphical diagram based on the circuit diagrams of relay logic hardware.

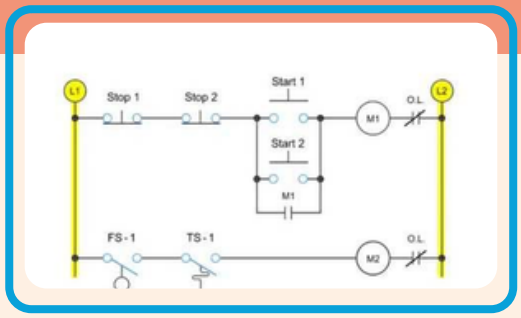
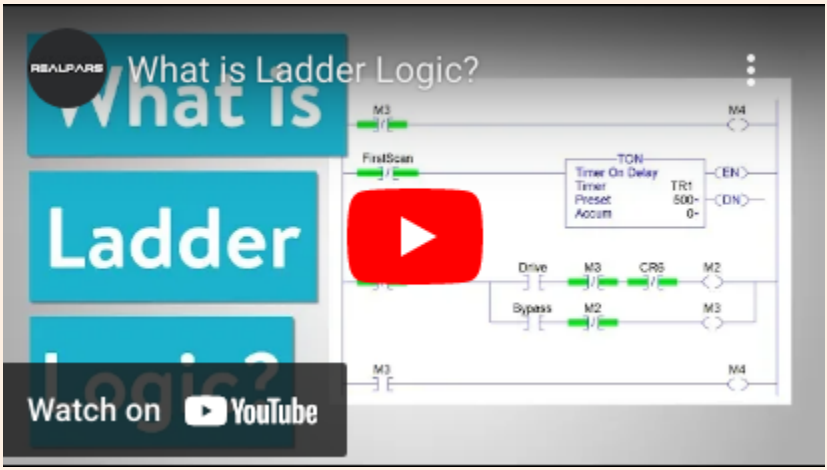


Figure 3.1: Example of ladder diagram



LADDER LOGIC: https://www.youtube.com/watch?v=qaI48NCUvkA

Instructional List/ Mnemonic Code

```
LD    A
AND   B
OUT   C
```

The ladder diagram cannot be read by the Programming Console. Therefore, the ladder diagram should be converted to mnemonic code. The mnemonic code provides the same information as the ladder diagram and can be typed directly on the Programming Console.

Structured Text

Cylinder out = (Input A OR Input B) AND Output C

Structed text is a textual grouper-type language that contains expressions and instructions.

Sequential Function Chart

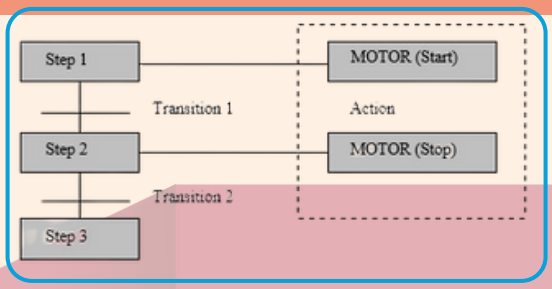


Figure 3.2: Example of sequential function chart

Sequential function chart is a type of graphic language. Its elements consist of steps, transitions, options and parallel branches. Each step shows the status of the program process active or inactive controls. A step contains actions that are based on transition. Actions, in turn, contain their own sequential structure.

Function Block Diagram

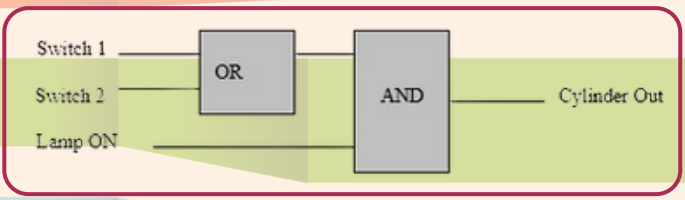


Figure 3.3: Example of function block diagram

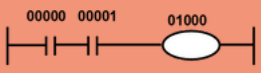
Function block diagram is a kind of graphic language. The elements found in the diagram of this function are graphically described functions and function blocks.

These elements are connected to the signal flow line and are directly connected to the network.

Ladder Diagram and Mnemonic Code

SERIES

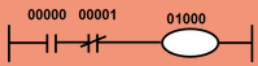
a) AND
Two switch connected in series NO



LD 00000	WRITE
AND 00001	WRITE
OUT 01000	WRITE
END (FUN 01)	WRITE

SERIES

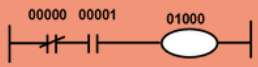
b) AND NOT
Two switch connected in series NO & NC



LD 00000	WRITE
AND NOT 00001	WRITE
OUT 01000	WRITE
END (FUN 01)	WRITE

SERIES

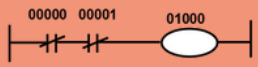
c) LD NOT
Two switch connected in series NC & NO



LD NOT 00000	WRITE
AND 00001	WRITE
OUT 01000	WRITE
END (FUN 01)	WRITE

SERIES

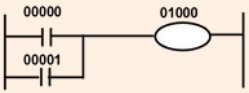
d) LD NOT
Two switch connected in series both are NC



LD NOT 00000	WRITE
AND NOT 00001	WRITE
OUT 01000	WRITE
END (FUN 01)	WRITE

PARALLEL

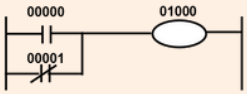
a) OR
Two switch connected in parallel NO



LD 00000	WRITE
OR 00001	WRITE
OUT 01000	WRITE
END (FUN 01)	WRITE

PARALLEL

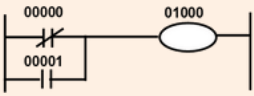
b) OR NOT
Two switch connected in parallel NO & NC



LD 00000	WRITE
OR.NOT 00001	WRITE
OUT 01000	WRITE
END (FUN 01)	WRITE

PARALLEL

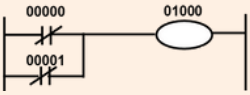
c) OR
Two switch connected in parallel NC & NO



LD NOT 00000	WRITE
OR 00001	WRITE
OUT 01000	WRITE
END (FUN 01)	WRITE

PARALLEL

d) OR NOT
Two switch connected in parallel NC & NC



LD NOT 00000	WRITE
OR NOT 00001	WRITE
OUT 01000	WRITE
END (FUN 01)	WRITE

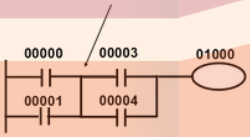
Figure 3.4: Example of ladder diagram and mnemonic code series and parallel

Clip / Combine

AND LD
OR LD

CLIP SERIES

AND LD
Connected in series in multi stage



LD	00000	WRITE
OR	00001	WRITE
LD	00003	WRITE
OR	00004	WRITE
AND LD		WRITE
OUT	01000	WRITE
END (FUN 01)		WRITE

The AND LD command has no physical contact device.

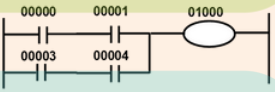
Just a programming tool to solve complex AND functions such as connecting several OR, OR NOT, OR LD in a series state.

Figure 3.5: Clip series

CLIP PARALLEL

OR LD
Connected in parallel in multi stage

OR LD command has no physical contact device.
Only one programming tool to solve complex OR functions such as one LD connected series (or LD NOT) in parallel with another series of contacts.

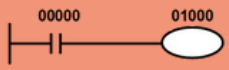


LD	00000	WRITE
AND	00001	WRITE
LD	00003	WRITE
AND	00004	WRITE
OR LD		WRITE
OUT	01000	WRITE
END (FUN 01)		WRITE

Figure 3.6: Clip parallel

OUTPUT

a)OUT
Output terminal generate voltage



LD	00000	WRITE
OUT	01000	WRITE
END (FUN 01)		WRITE

OUTPUT

b) OUT NOT
Output terminal generate voltage but in reverse condition

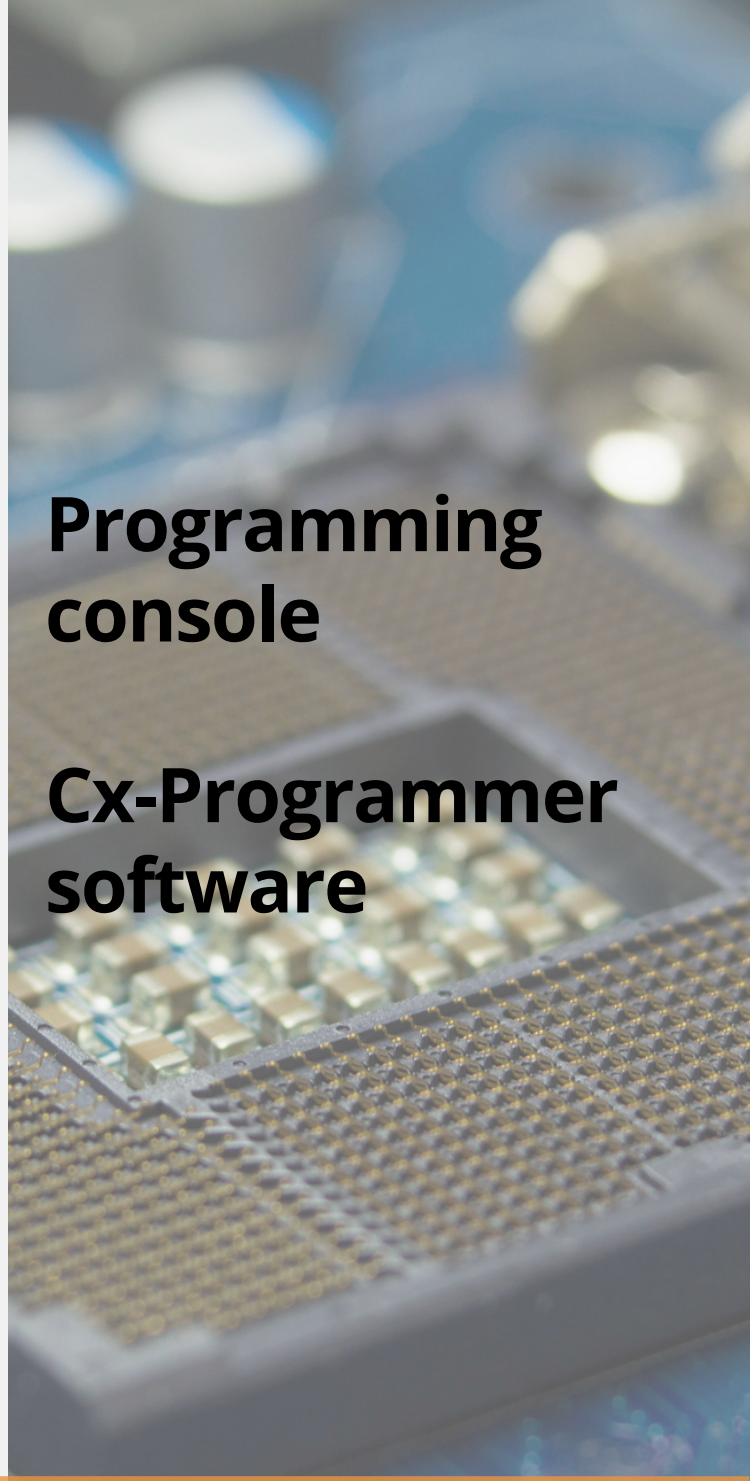
LD	00000	WRITE
OUT NOT	01000	WRITE
END (FUN 01)		WRITE

Figure 3.7: Output terminal generate voltage

04

BASIC PROGRAMMING

04 BASIC PROGRAMMING



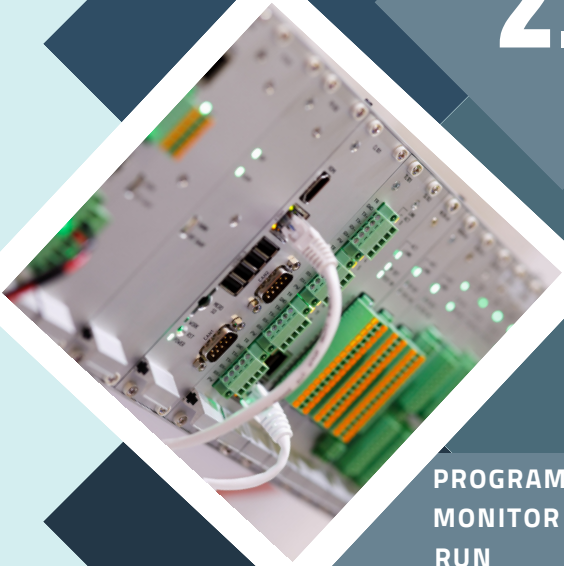
Programming console

Cx-Programmer software

BASIC PROGRAMMING

PROGRAMMING CONSOLE

2.1



PROGRAM
MONITOR
RUN

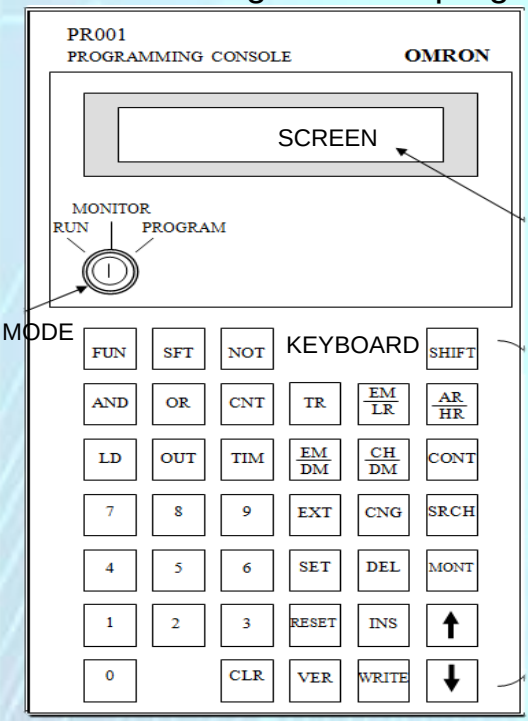
BASIC PROGRAMMING

Method to write a program:

a. **Use programming console to write a program**
b. **Use Cx- Programmer software**

a. Using Programming Console

Before starting the PLC program, first familiarized with the set and the keys on the Keyboard called programming console.



PROGRAM – This mode is used when you want to enter, amend or correcting progra

MONITOR – This mode is used when you want to set the value of the counter and timer when the PLC is operating

RUN – This mode is used to run a program when the pro-gram is ready included

Figure 4.1: Programming console

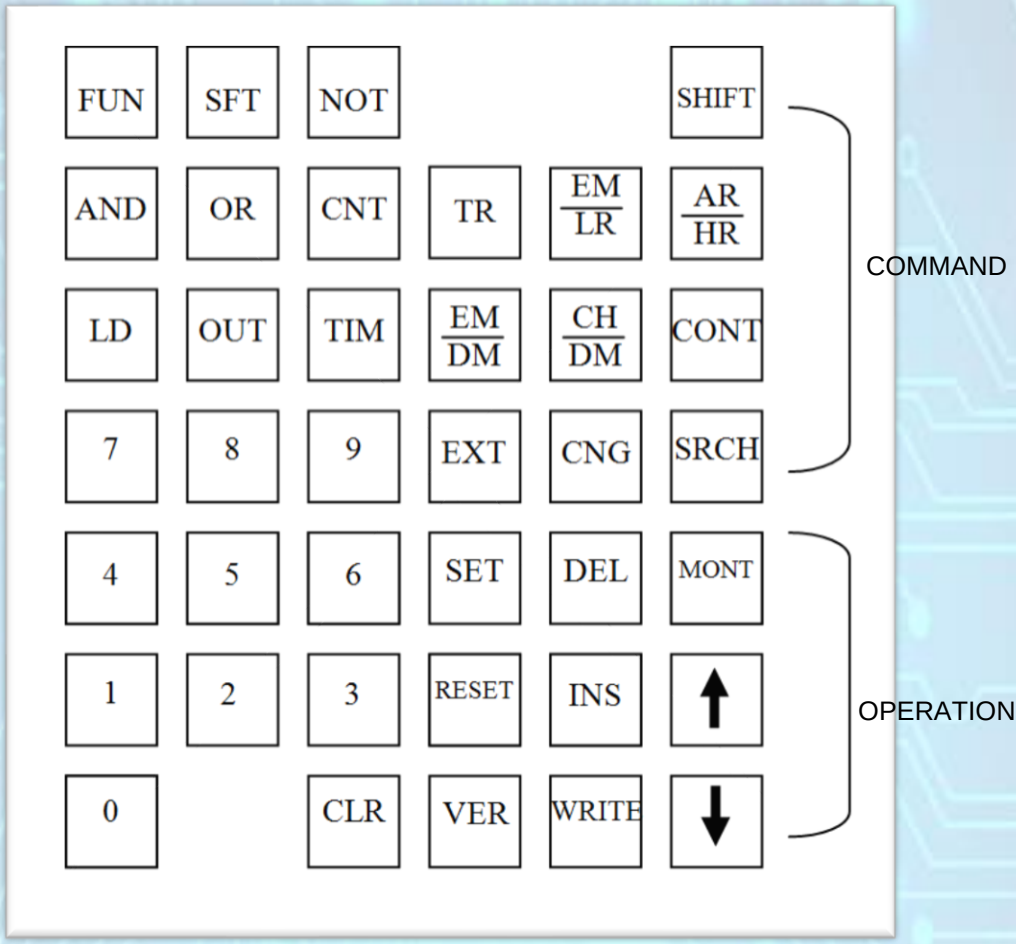


Figure 4.2: Part of keyboard

PASSWORD

PLC has a password to prevent someone who is not concerned from entering into the program.

PASSWORD display will appear on the display as soon as the supply is applied to the PLC.

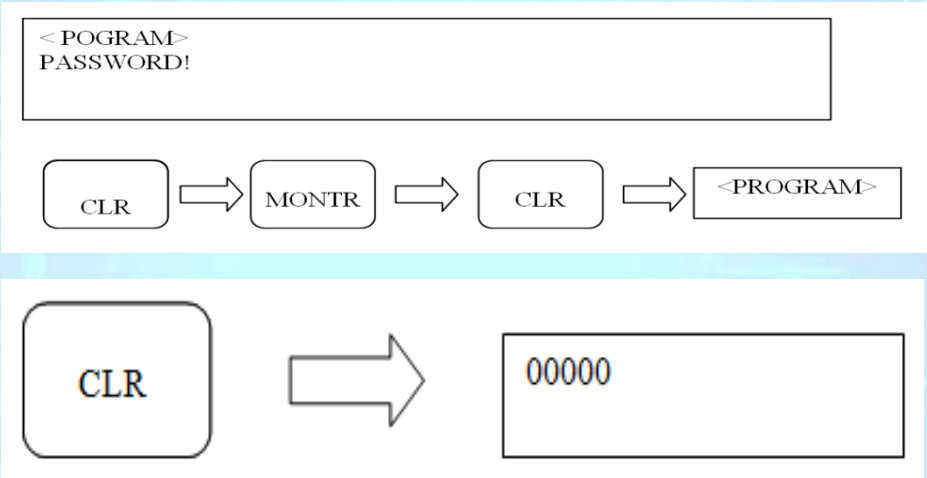


Figure 4.3: Password display for PLC

DELETE ALL PREVIOUS PROGRAM

The previous program will remain in memory while the RAM is not deleted. This is because there is a backup battery that always works even holding supply off.

To delete all previous programs ALL CLEAR operation should be done with the following command:

Mode selector switched to PROGRAM

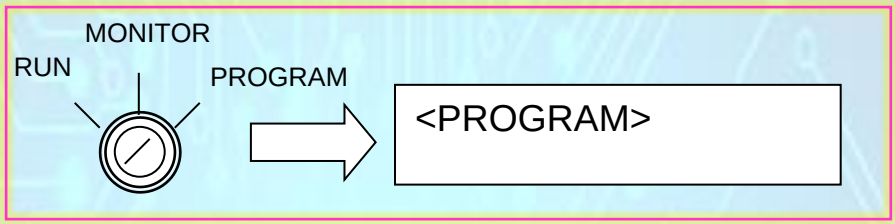


Figure 4.4: Mode selector

Press CLR untill 00000 displayed at screen

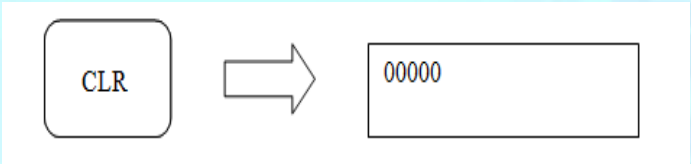


Figure 4.5: CLR display

PLC memory will be lost after the following sequence of keys is pressed:

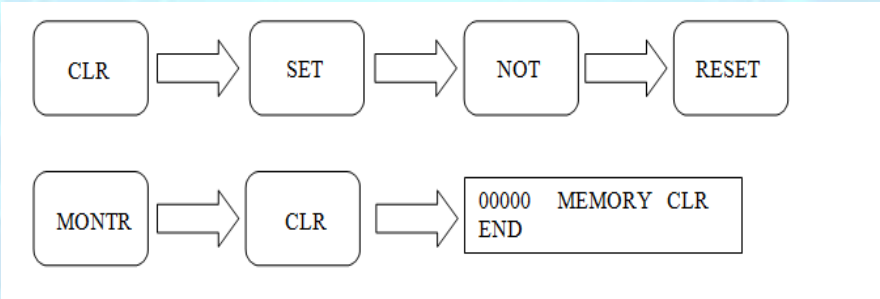
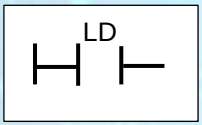
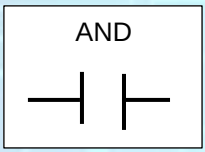
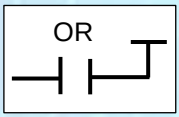
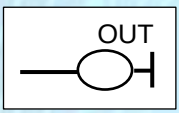


Figure 4.6: PLC memory

THE COMMAND KEYS

FUN	Numerous special application command called FUNctions may be using this key.
	Loads input points into the program and provide a means of branching points.
	AND allows additional points to be connected together, to form a series circuit.
	OR allows point to be joined to the circuits in such a way that allows parallel connections.
	The OUTput commands.
TIM	The TIMers are controlled using the command.
CNT	The CouNTers are controlled using this com-

NOT	Used with LD, AND and OR command keys to designate
HR	Designates Holding Relays.
TR	Designates Temporary Relays.
SFT	Display the operations of the SHIFT register.
SHIFT	SHIFT is used to obtain the alternate function of the four keys with more than one use, labelled, PLAY, RECORD
0 ↓ 9	When inputting decimal or hexadecimal numbers when programming.

CALLING BACK PROGRAM

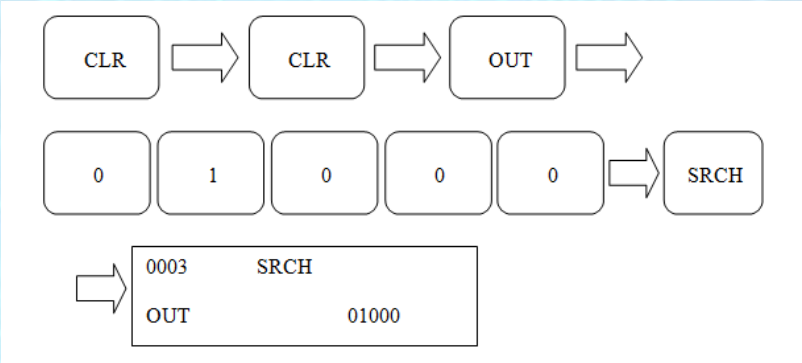


Figure 4.7: Calling back program

Calling back program function to recall a program that has been programmed in PLC based on the address that has been registered

SEARCH PROGRAM

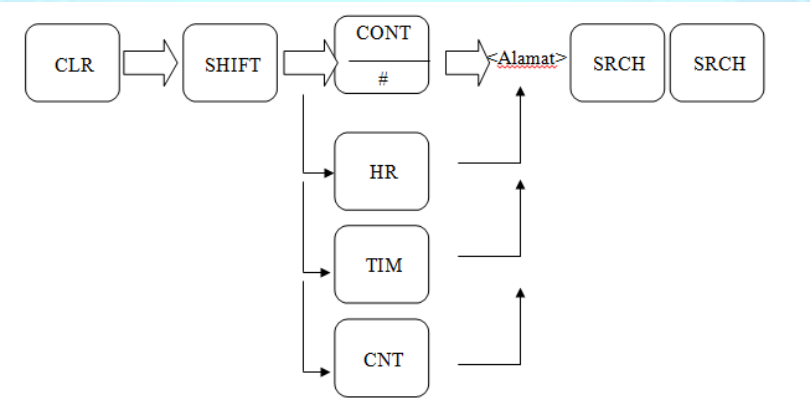


Figure 4.8: Search program

Search program use to search programs in PLC based on instructions that have been execute.

INSERT PROGRAM

Addr.	Instruction	Data
0000	LD	00000
0001	AND	00001
0002	LD	10000
0003	AND NOT	00002
0004	OR LD	
0005	AND	00003
0006	AND NOT	00004
0007	OUT	10000
0008	END(01)	

After Insertion

Addr.	Instruction	Data
0000	LD	00000
0001	AND	00001
0002	LD	10000
0003	AND NOT	00002
0004	OR LD	
0005	AND	00003
0006	AND NOT	00004
0007	AND	00005
0008	OUT	10000
0009	END(01)	

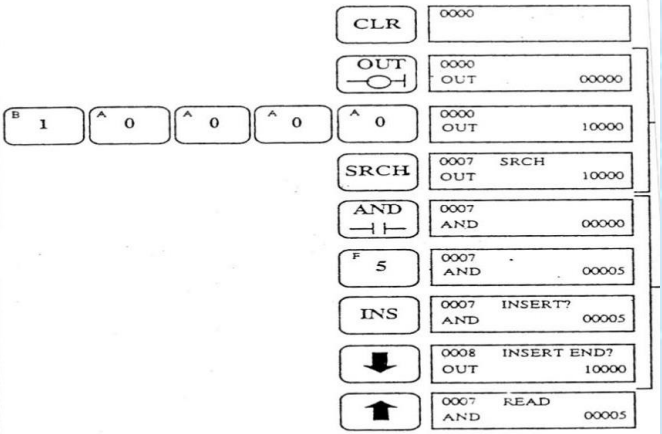


Figure 4.9: Insert program

The function of insert program is to include a left program line or changes that want to apply to an existing program.

DELETE PROGRAM

Addr.	Instruction	Data
0000	LD	00000
0001	AND	00001
0002	LD	10000
0003	AND NOT	00002
0004	OR LD	
0005	AND	00003
0006	AND NOT	00004
0007	OUT	10000
0008	END(01)	

After Insertion

Addr.	Instruction	Data
0000	LD	00000
0001	AND	00001
0002	LD	10000
0003	AND NOT	00002
0004	OR LD	
0005	AND	00003
0006	AND NOT	00004
0007	AND	00005
0008	OUT	10000
0009	END(01)	

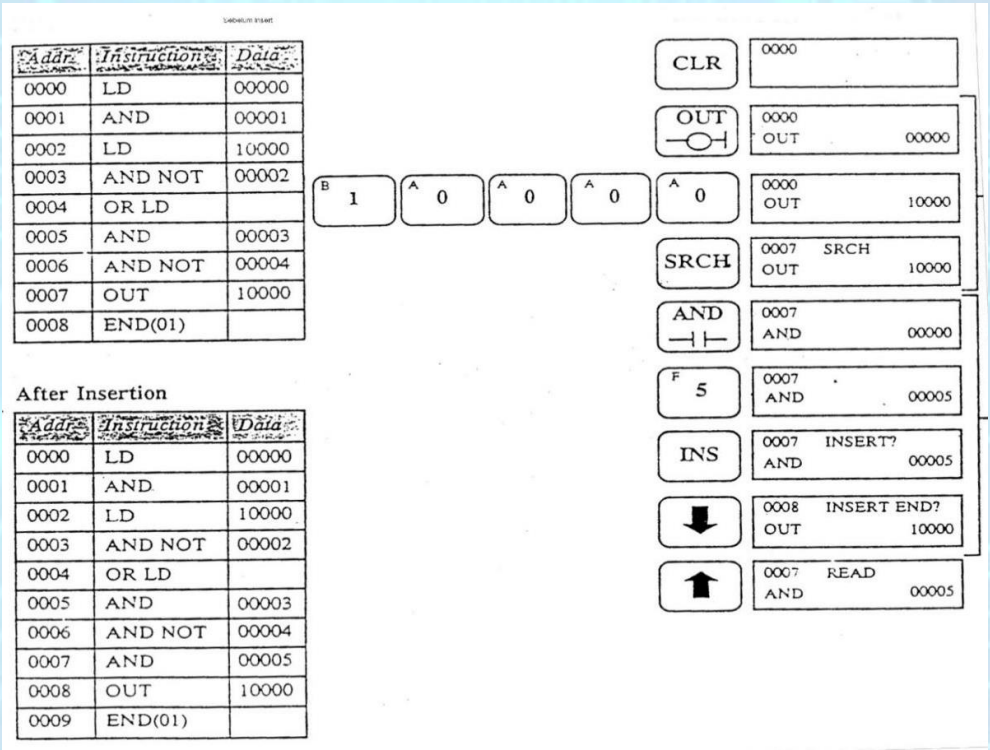


Figure 4.10: Delete program

Delete program is to remove program line or changes that want to apply to an existing program.

BASIC PROGRAMMING

CX PROGRAMMER SOFTWARE

2.2

BASIC PROGRAMMING

Method to write a program:

a. **Use programming console to write a program**
b. **Use Cx-Programmer software**

b.Use Cx-Programmer software

To start programming

To start programming sheet, click on 'File' and select 'New'

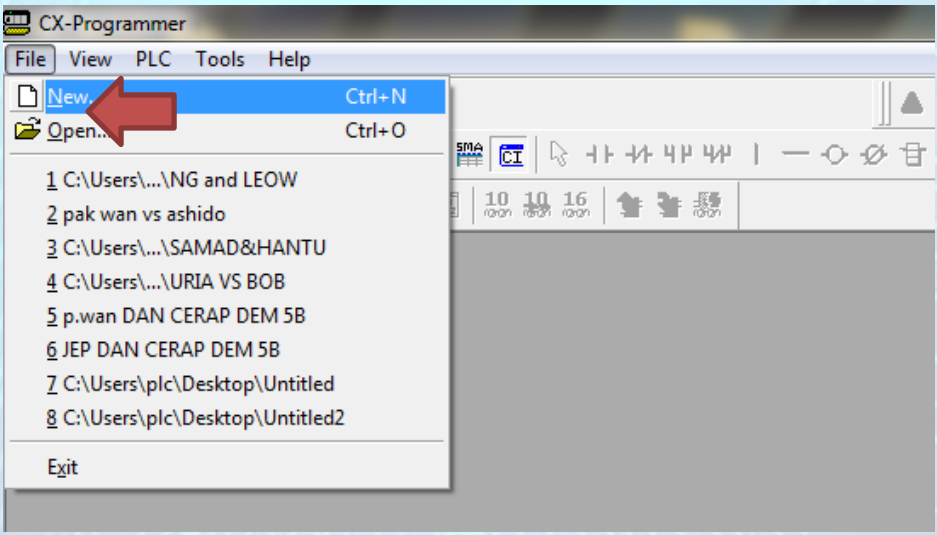


Figure 4.11: Start new program

Name the programming to be made so easily to revise

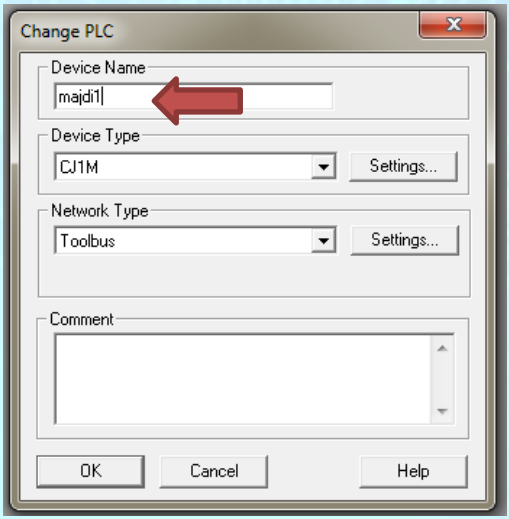


Figure 4.12: Program / device name

Select the type of PLC series. The series can be consulted on the PLC used.

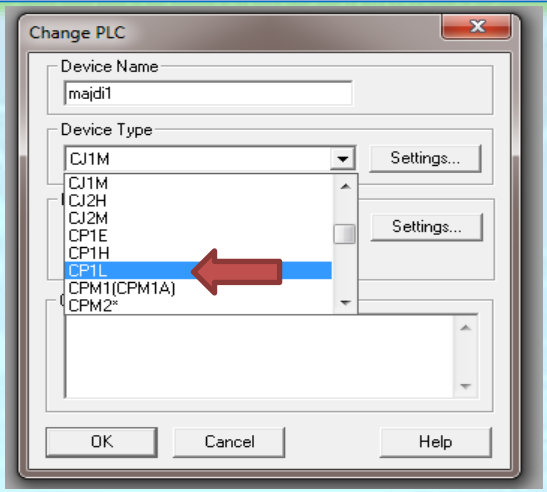


Figure 4.13: PLC type selection

Select the type of PLC series CPU based on the previous move.

Example: CP1L

Rightmost letter is a symbol for the type of CPU. This means, CPU type is type L

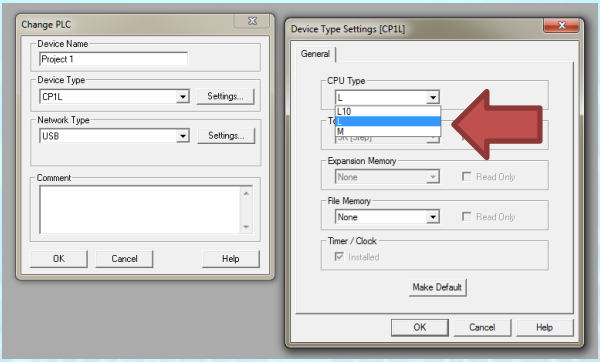


Figure 4.14: CPU type selection

Select the type of network used by the PLC used in order to communicate with the computer / software.

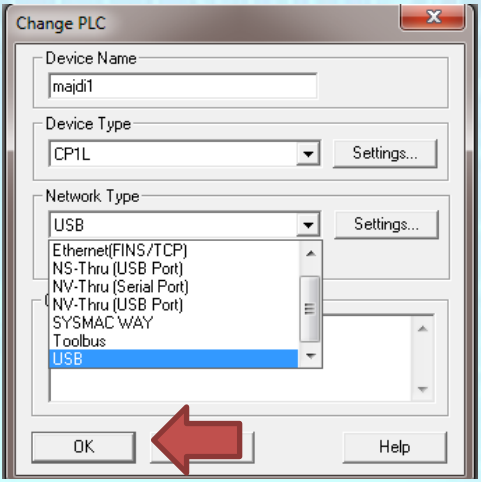


Figure 4.15: Network type selection

After everything is finished, click 'OK'

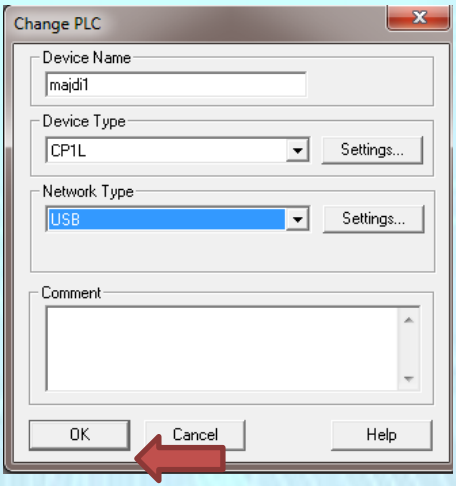


Figure 4.16: Execute the program

Barring any problems, the display as shown below will appear

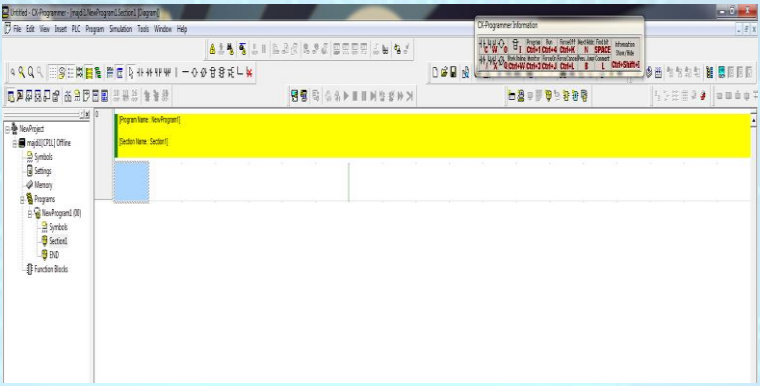


Figure 4.17: Screen for progamming

The blue box is the place where any form of symbols whether the contact or coil placed to represent the input and output.

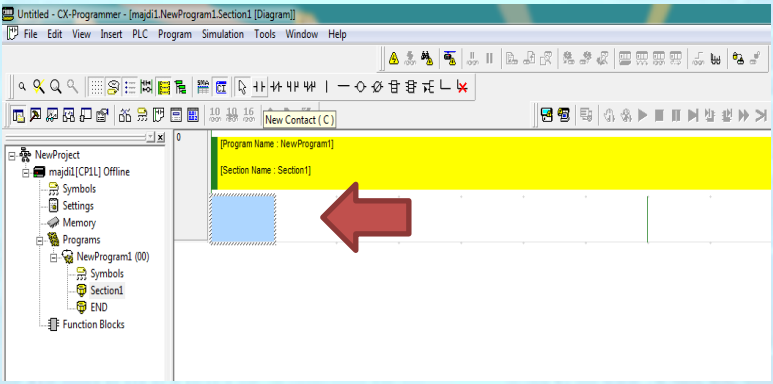


Figure 4.18: Blue box

The arrow indicates the icon used to represent input and output.

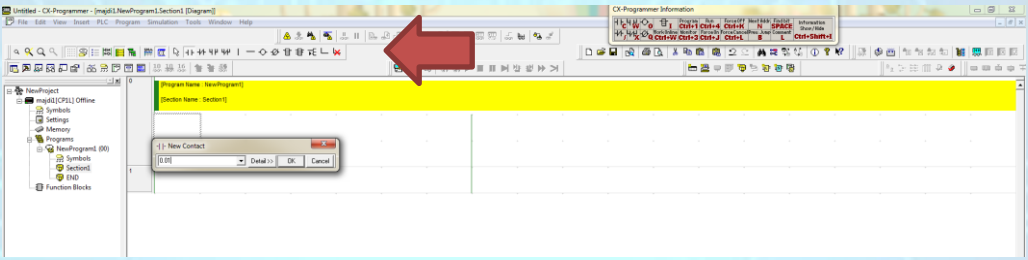


Figure 4.19: Input and output icon

The address must be entered when the icon is selected.

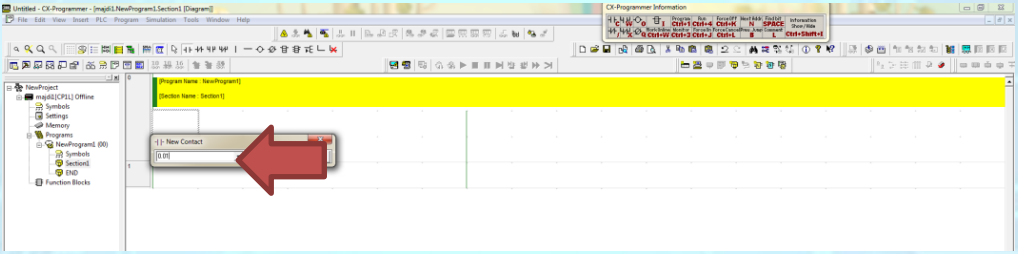


Figure 4.20: Insert address

Once the address is entered, it must be labeled/comment to facilitate review or to help others. Then Click OK.

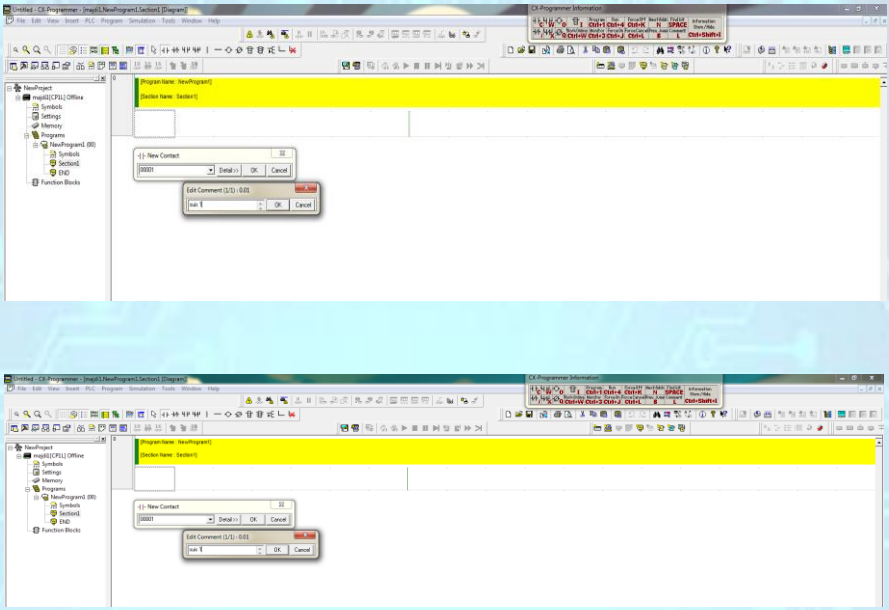


Figure 4.21: Insert label/comment

The blue box will shift to the right to allow the user to enter the next command

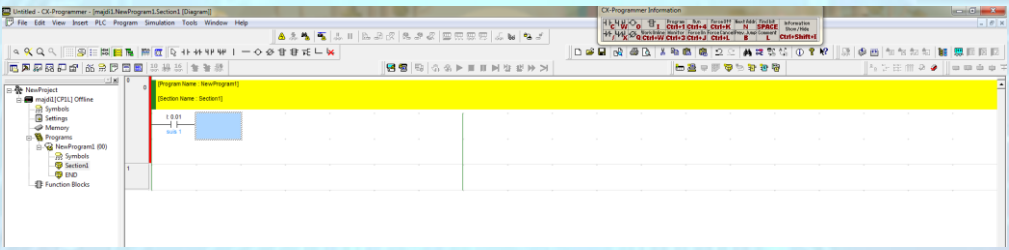


Figure 4.22: Ready to another command

Vertical lines will remain red if the command line is not perfect. Output command is the last command for every line of command.

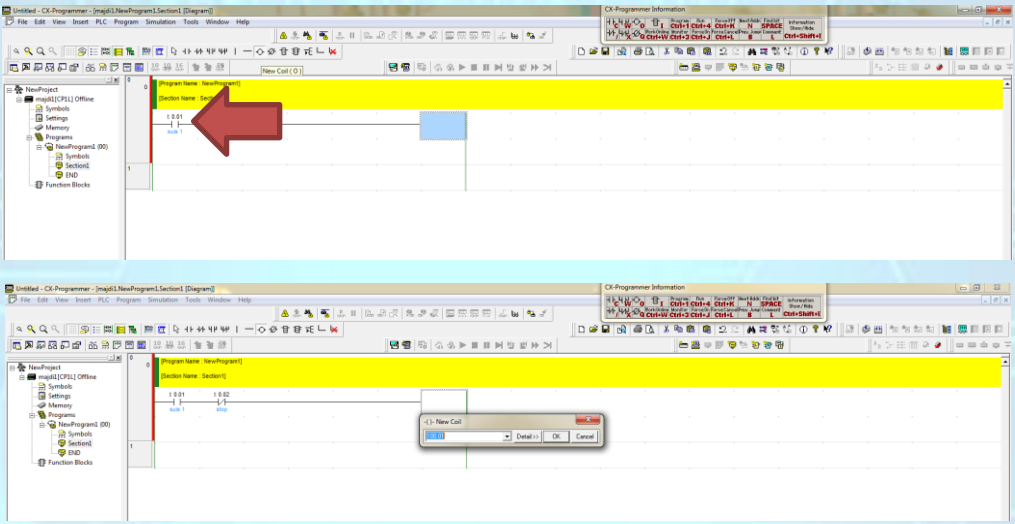


Figure 4.23: Vertical lines signal

Output also must be included and must be labeled & addressed.

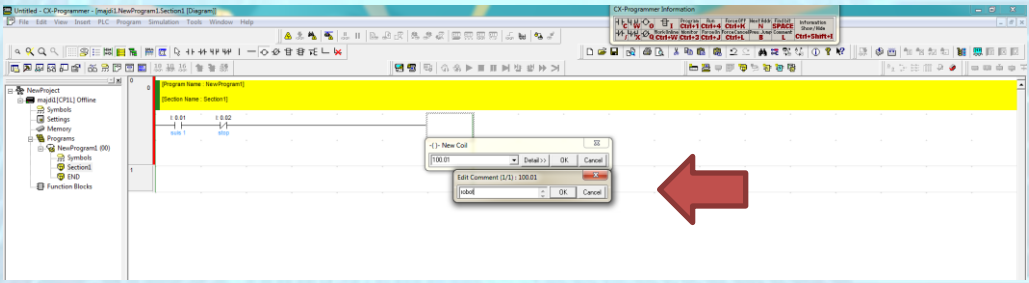


Figure 4.24: Output declaration

When the command line was done, the red vertical line will disappear.

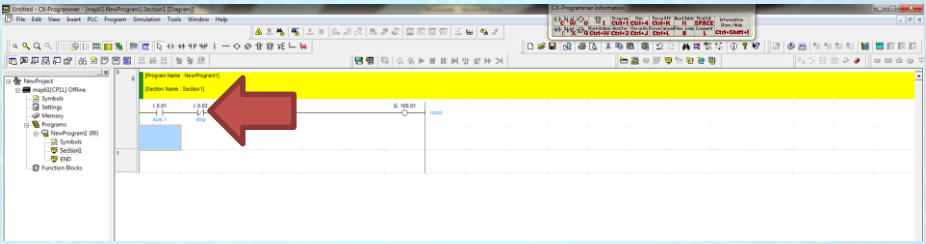


Figure 4.25: Complete instruction line

To ensure that the instructions given in accordance with the conditions set, it must be in 'compile' in advance to ensure it is free of 'error' and 'warning'.

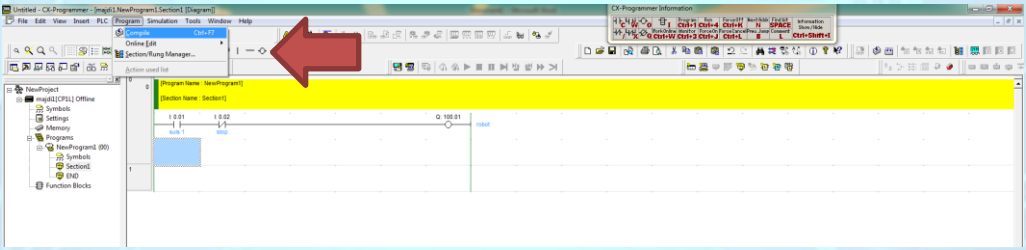


Figure 4.26: Compiling the program

If there don't have any 'error' and 'warning', the next step can be taken.

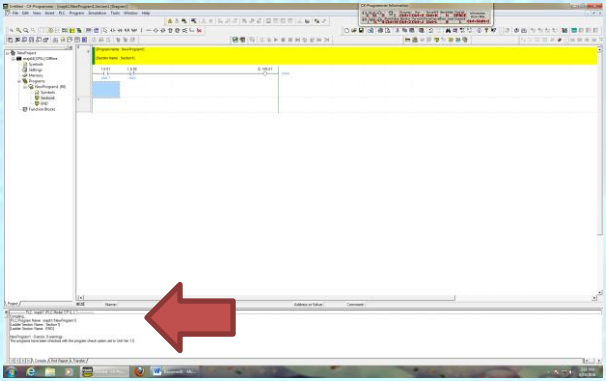
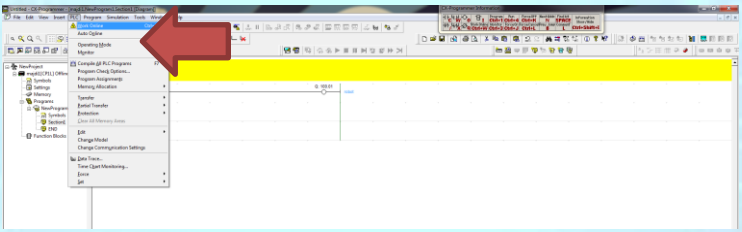


Figure 4.27: Checking error / warning

Instructions 'Work Offline' must be activated so that the PLC and Computer / Software can communicate. Then Click ’YES’



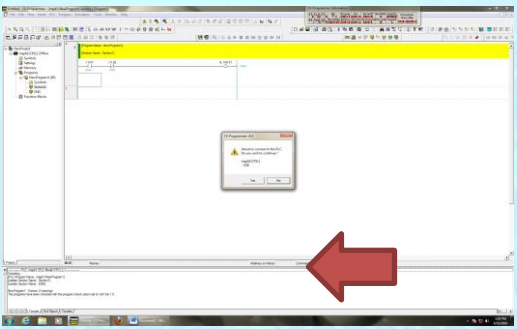


Figure 4.28: Communicate with PLC

When communication between the PLC and the computer successfully connected, the green line will appear.

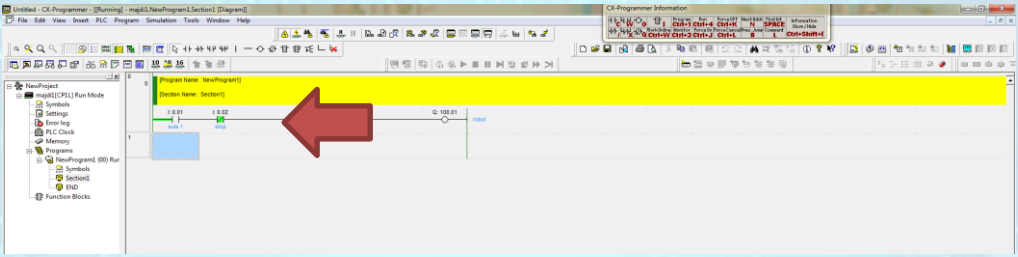
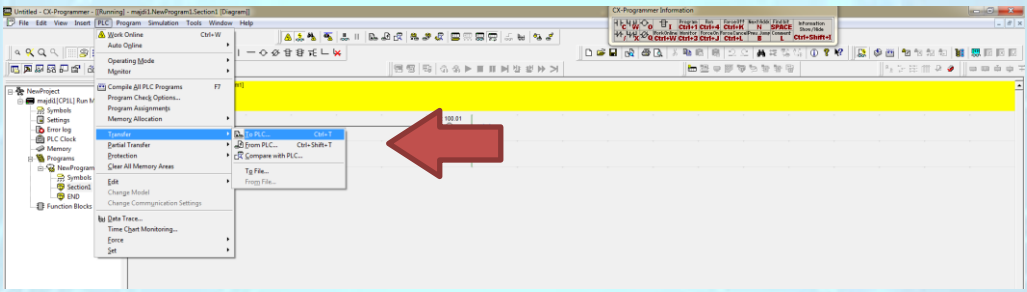


Figure 4.29: Proof of communicating

The command has to be downloaded from a PC / Software to the PLC as shown below. Then Click ‘OK’.



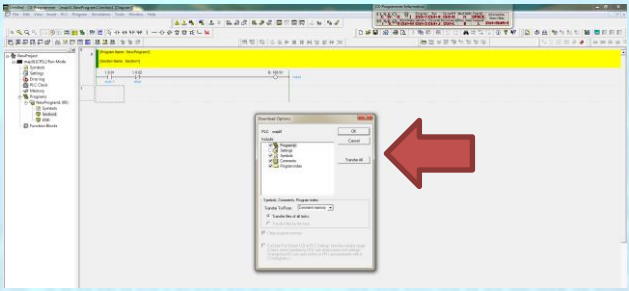


Figure 4.30: Download options

Click ‘YES’

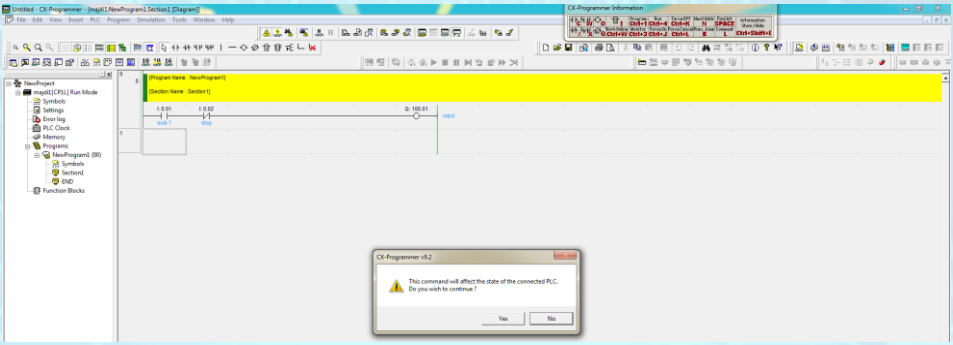


Figure 4.31: Agree to continue the process

Click ‘YES’

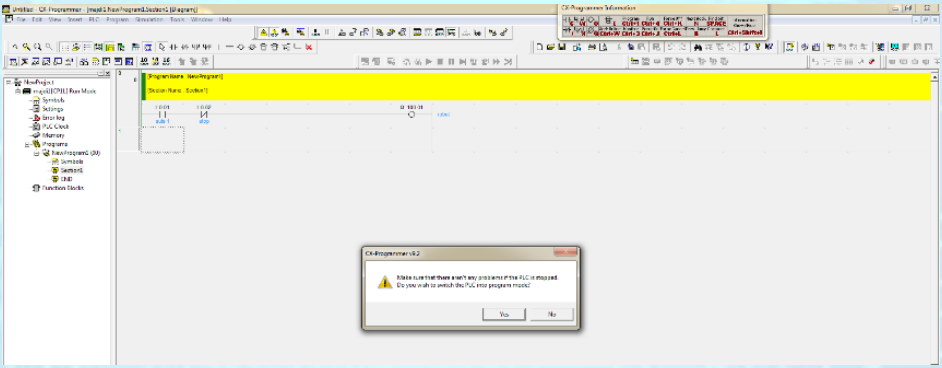


Figure 4.32: Change to program mode

The download process will take a few moments.

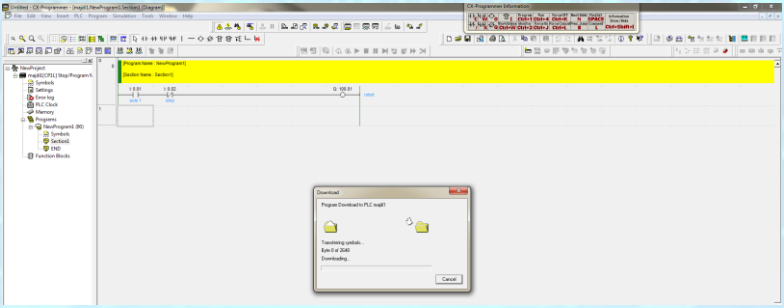


Figure 4.33: Download process

When appear that the download process is successful, click 'OK'.

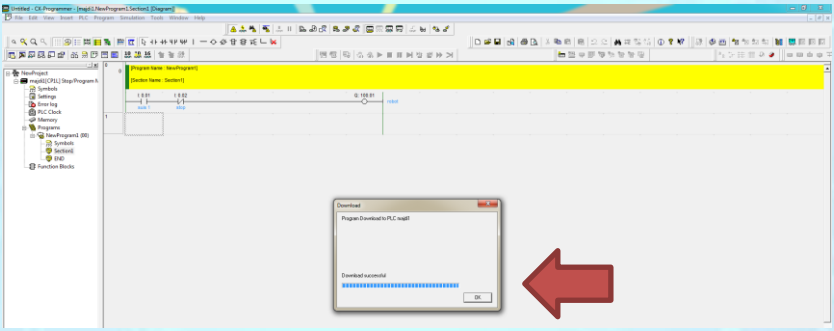


Figure 4.34: Successful download

Click 'YES' to enable the exchange of 'Program Mode' to 'Run Mode'

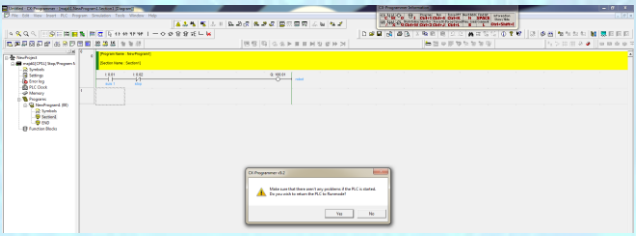


Figure 4.35: Change to Run Mode

Program that have been made ready for use. Users can turn any direction.

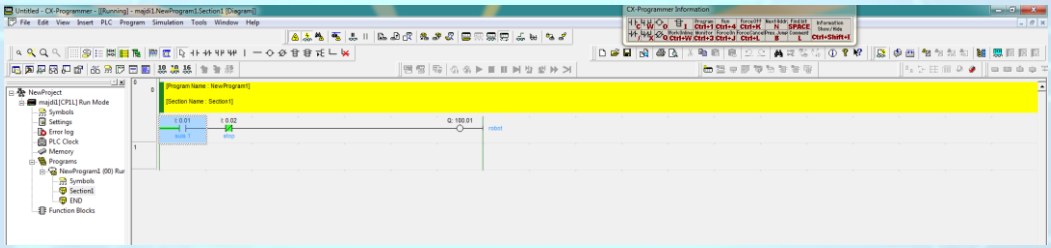


Figure 4.36: Program to use

The green line shows the current movement which enables output is activated.

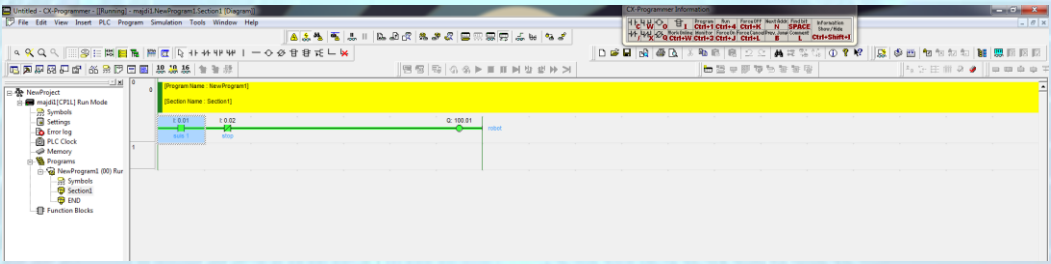


Figure 4.37: Program successfully performed

Timer

TIM – Timer

N - Address

SV - Set Value

Square icon used to represent TIMER

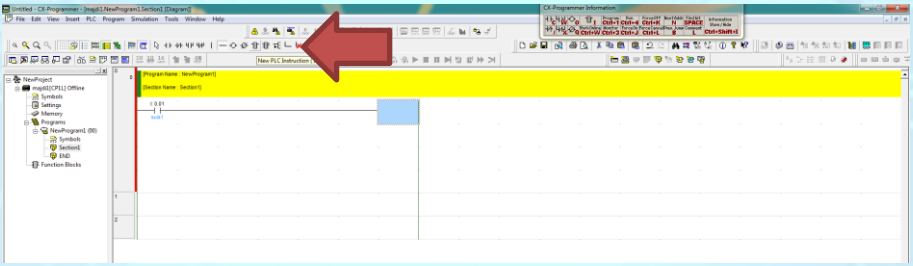


Figure 4.38: Timer icon

Instructions for TIMER must include the address and set the value as below:

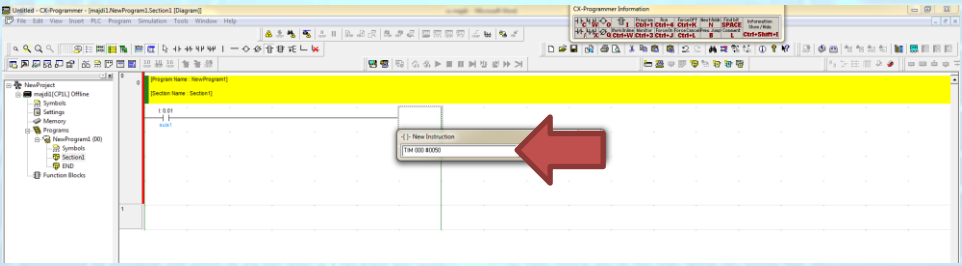


Figure 4.39: Timer declaration

The comments section or label, should be included as a guide to consumers.

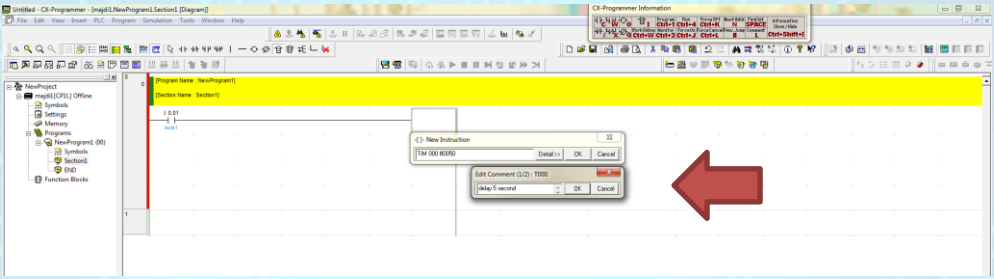


Figure 4.40: Comment / label declaration

If the address and the set value is entered correctly, the display will appear as below.

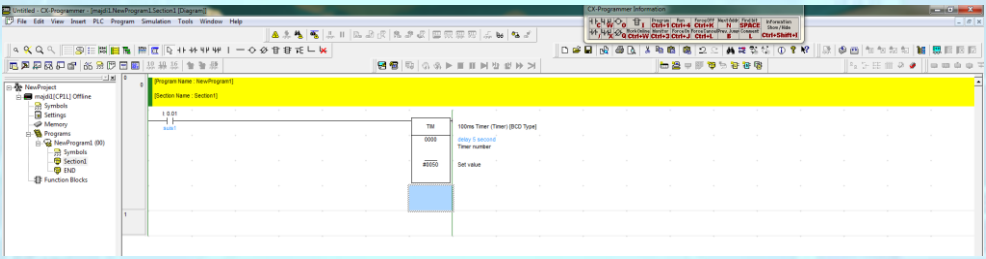


Figure 4.41: Successful Timer command

To continue with the next command, make sure the blue box is on the next block.

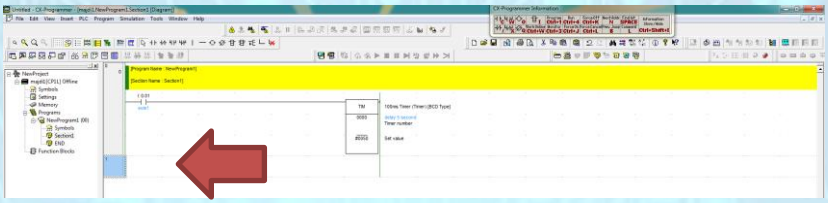
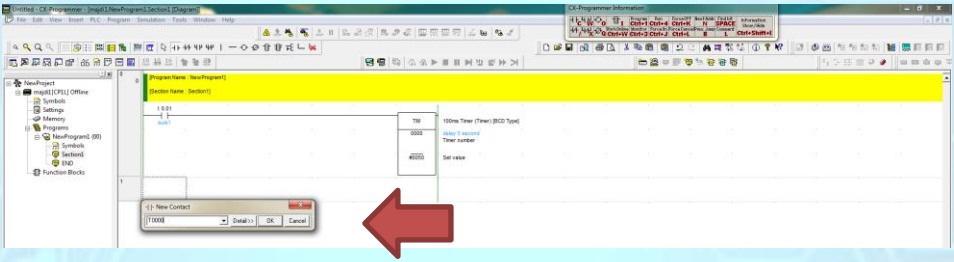


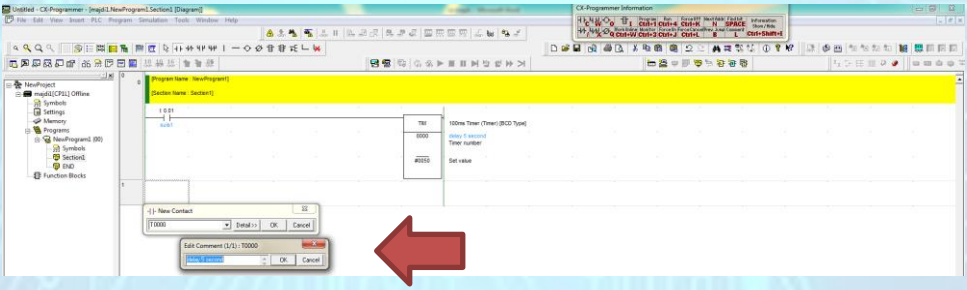
Figure 4.42: Program block

TIMER require 'contactor' which is same address to be able to run the desired operation.

However, there is little difference in it address:

TIM0000 ⟶ T0000





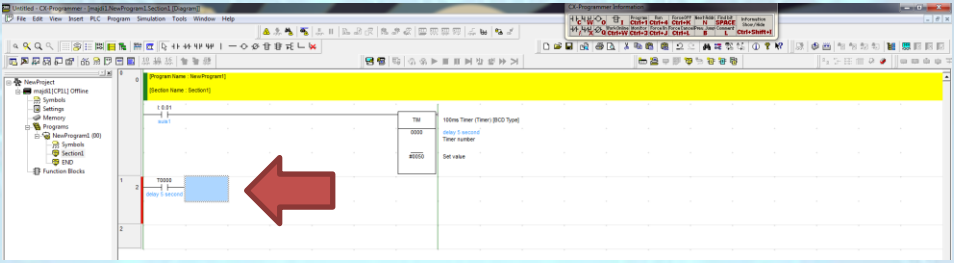


Figure 4.43: Contactor address for Timer

The next command is output controlled by TIMER.

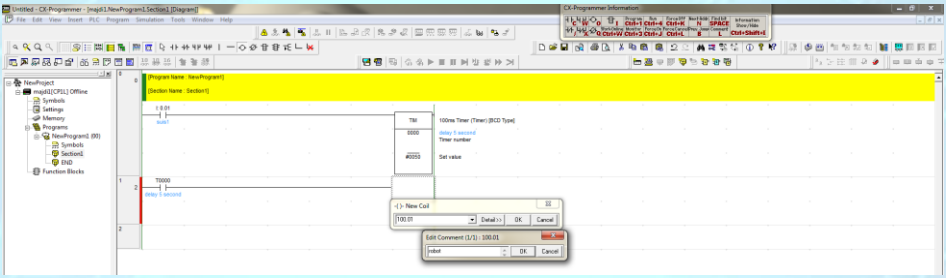


Figure 4.44: Output command

Based on this example, the switch 1 will only activate TIMER.

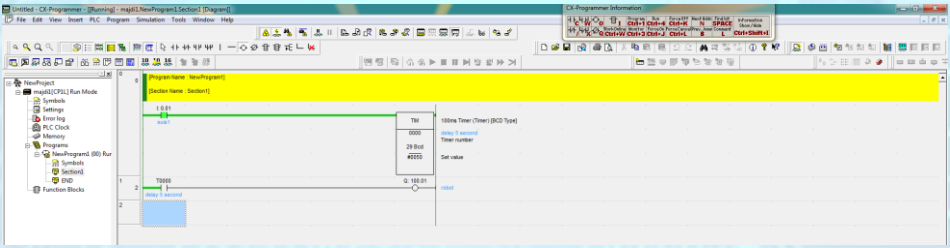


Figure 4.45: Rung 1 activation

When 'Set Value' was achieve, the timer will activate the 'contactor' that have same address.

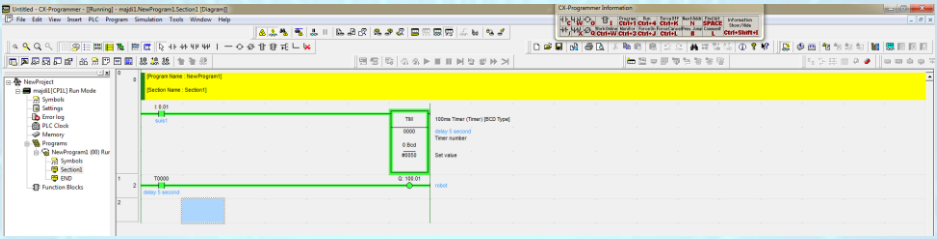


Figure 4.46: Rung 2 activation

Counter

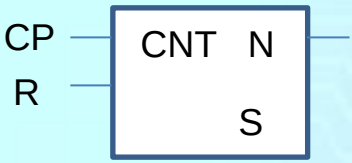
CNT – Counter

N - Address

SV - Set Value

CP - Count Pulse

R - Reset



COUNTER use the same icon like TIMER

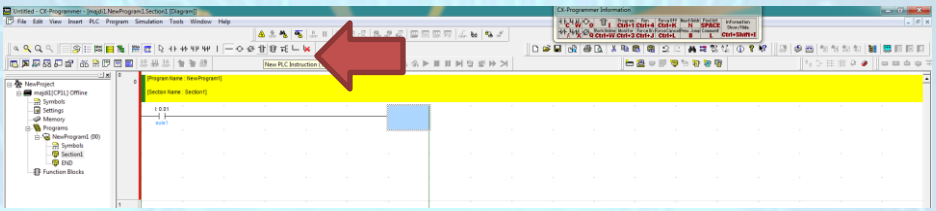


Figure 4.47: Counter icon

Instructions for COUNTER also include addresses and 'set value'.

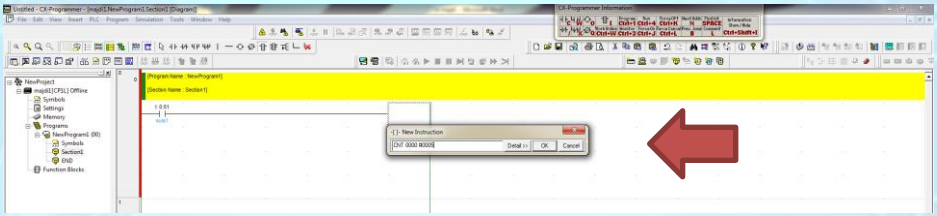


Figure 4.48: Counter declaration

The comments section or label, should be included as a guide to consumers.

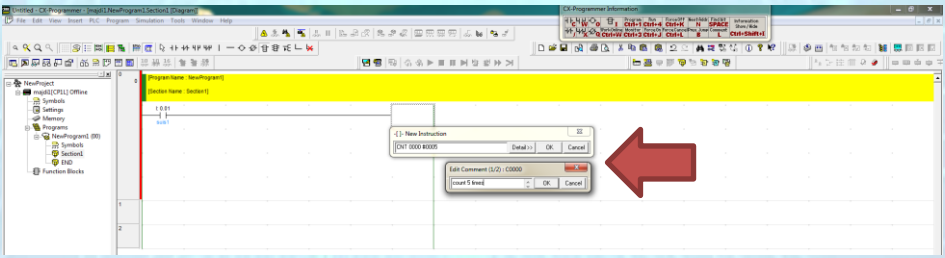
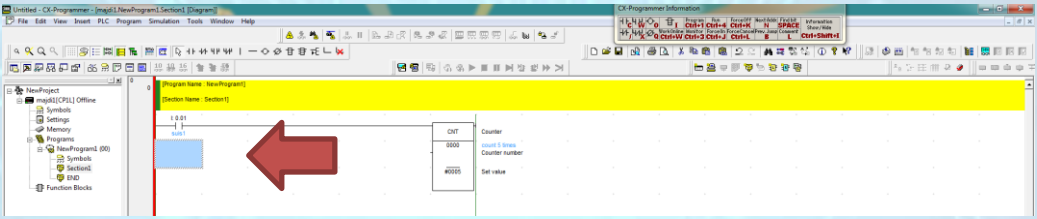
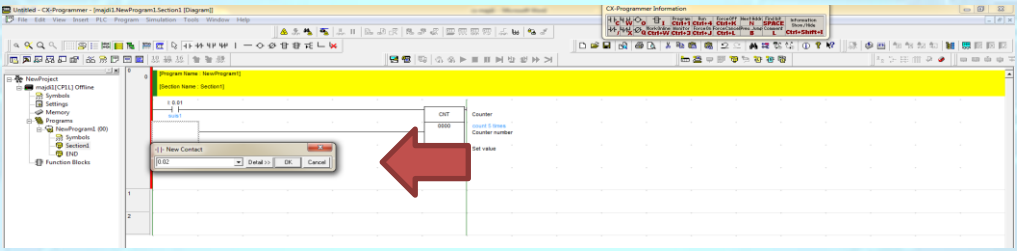


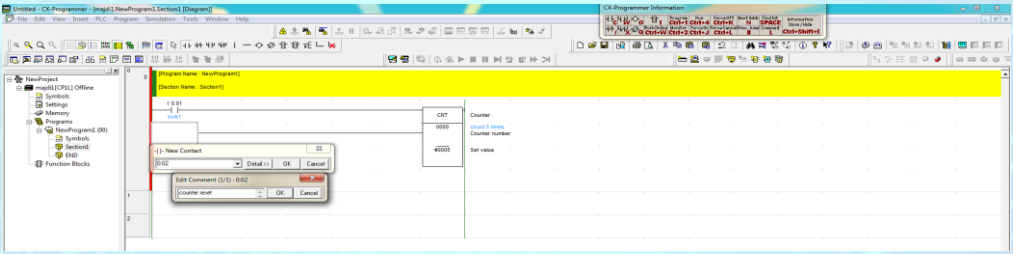
Figure 4.49: Comment / label declaration

Switches 'Reset' is to reset COUNTER to return to the origin.



The address is the same address that other inputs.





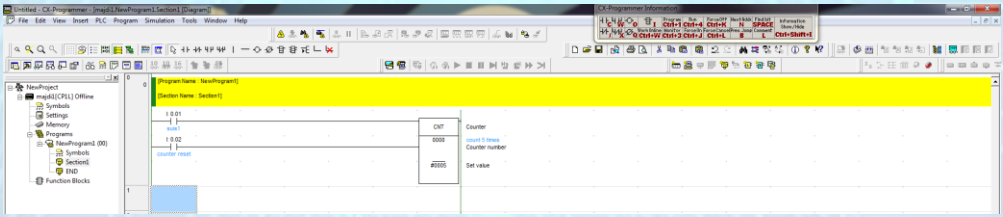


Figure 4.50: Counter reset button

COUNTER require 'contactor' which is same address to be able to run the desired operation.

However, there is little difference in it address:

CNT0000 ⟶ C0000

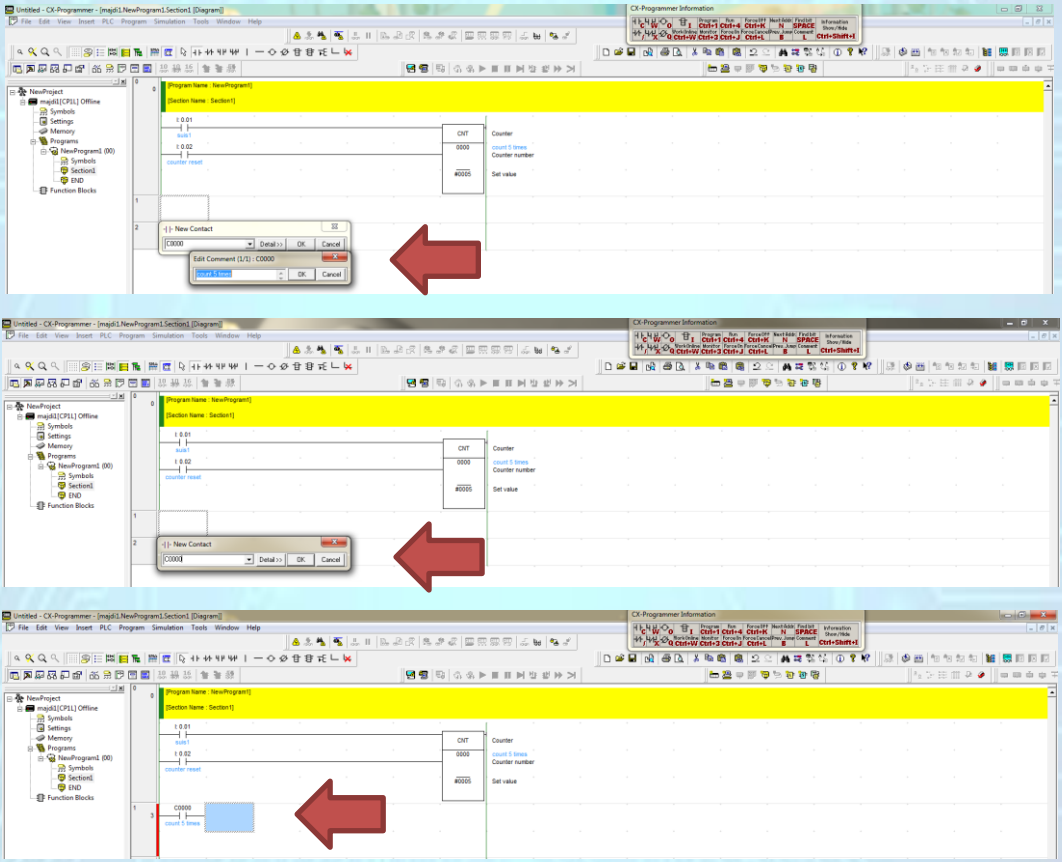


Figure 4.51: Contactor address for Counter

The next command is output that controlled by COUNTER.

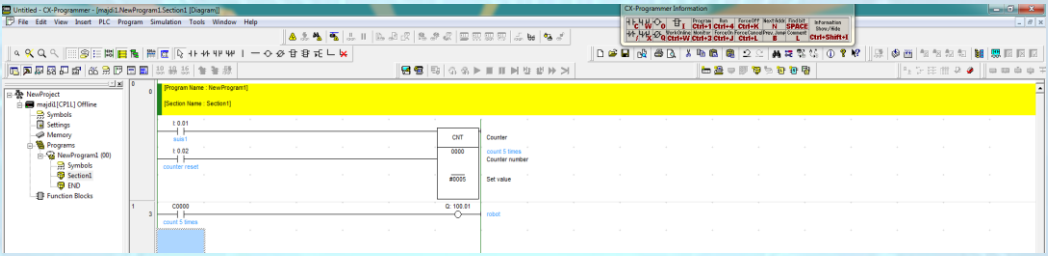
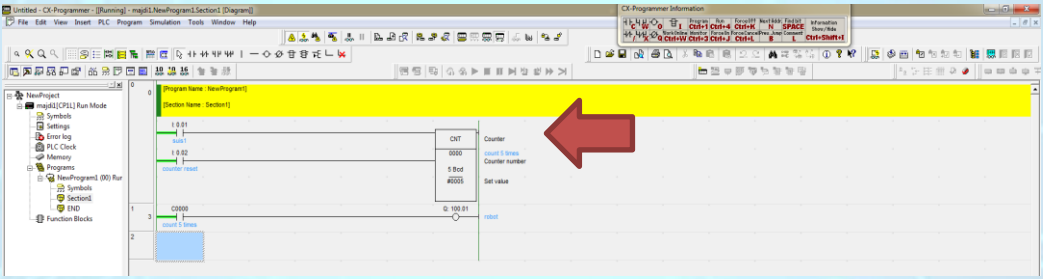
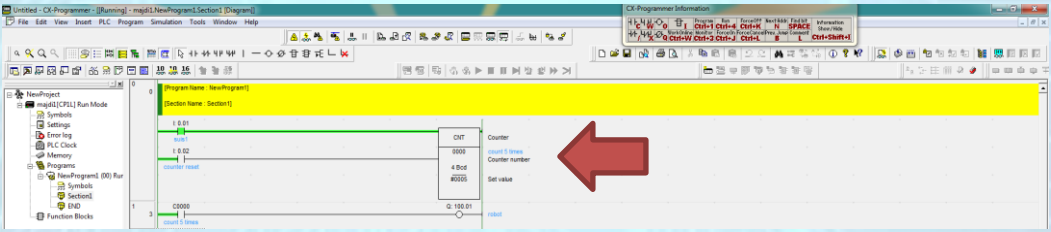


Figure 4.52: Output command

Based on this example, the switch 1 will turn COUNTER.

COUNTER will count down.





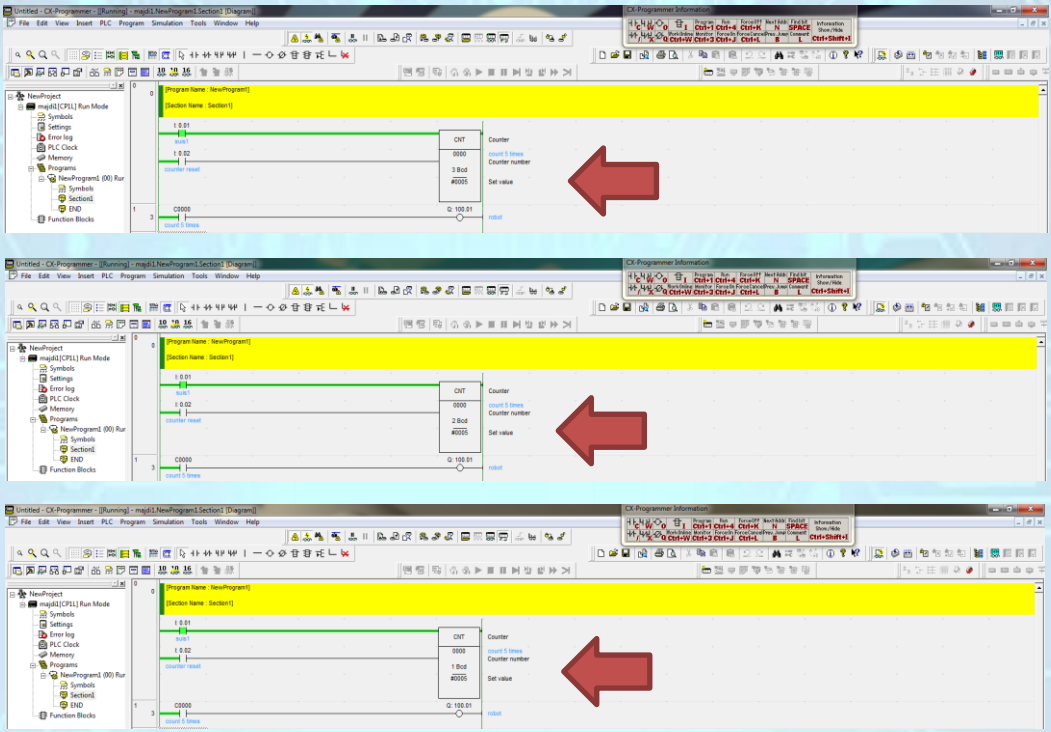


Figure 4.53: Program activation

When the ' set value ' was achieve COUNTER will enable contactor with the same address.

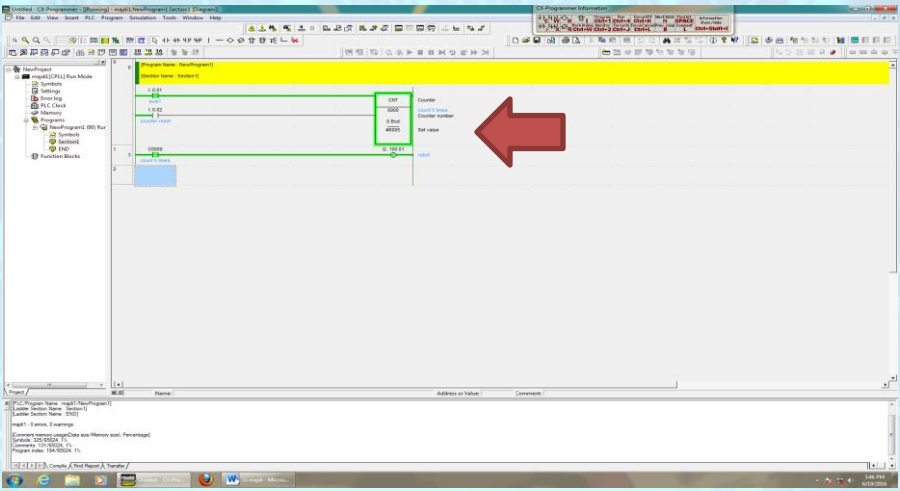
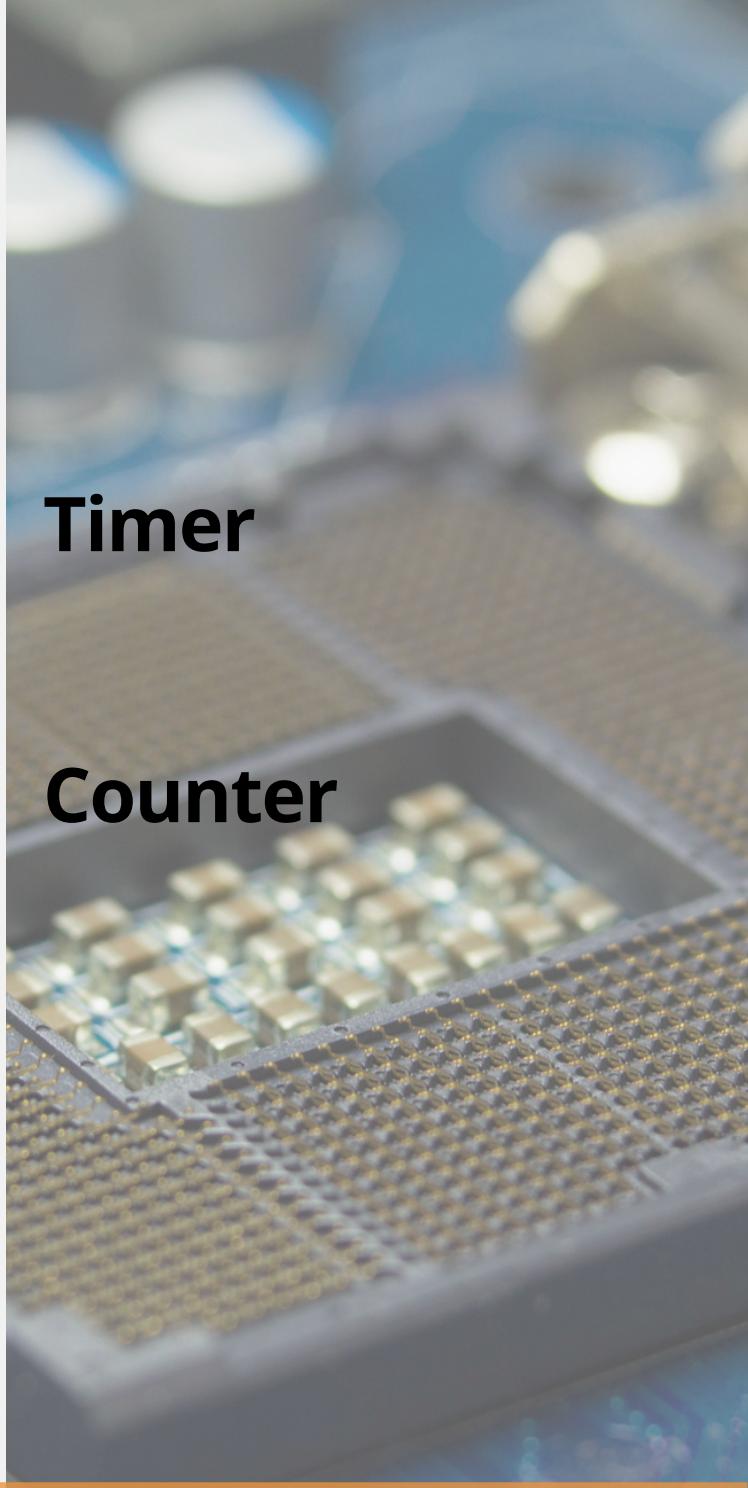


Figure 4.54: Counter activated

05

TIMER AND COUNTER

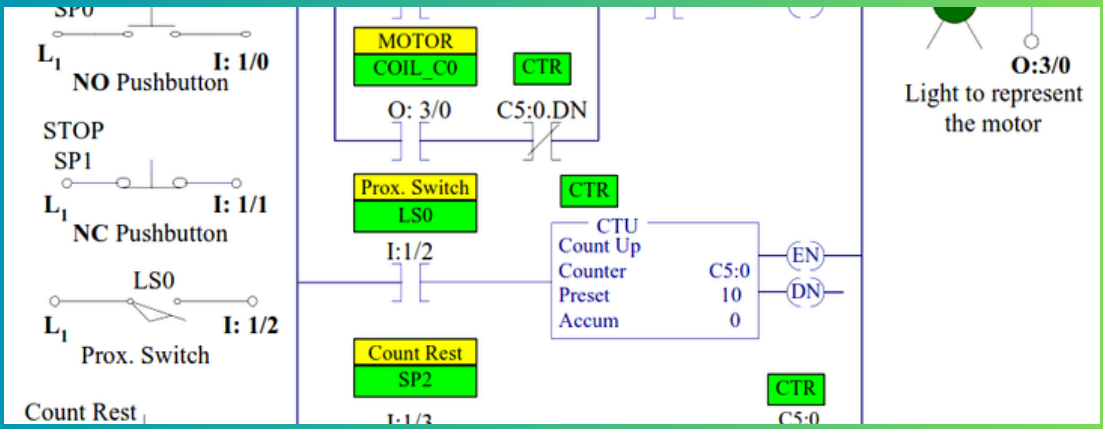
05 TIMER AND COUNTER



Timer

Counter

TIMER AND COUNTER



TOP NEWS OF THE MONTH

TIMER

>>> READ MORE

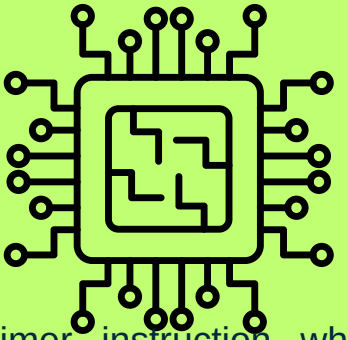
1.Explain the timer instruction set.
2.Solve problem using timer and counter instruction set.

READ MORE <<<

1.Explain the operation of a PLC counter.
2.Develop simple PLC program involving counters for industrial application

COUNTER

TIMER



>>> FUNCTION

a)To create a time delay.

b)TIM are decrementing ON-delay timer instruction which require a Timer number and a set value (SV) in decimal. Timer value is between 0 to 999.9 second.

c)The Timer number runs from 000 to 511(depend on PLC series). Any one of Timer number cannot be defined twice i.e, once it has been used in timer it cannot be used in counter.

d)The overall duration or elapsed time, for a timer operation cycle, is calculated by multiplying the present value by the timer resolution (0.1second).

e)A timer is activated when its execution condition goes ON and is reset (to SV) when the execution condition goes OFF. Once activated, TIM measures in units of 0.1s from SV

f)If the execution condition remains ON long enough for TIM to time down to zero, the completion flag for the TC number used will turn ON and will remain ON until TIM is reset (i.e, until its execution conditions is goes OFF).

g)Timers in interlocked program sections are reset when the execution condition for IL(02) is OFF. Power interrupts also reset timers. If a timer that is not reset under these conditions is desired, SR area clock pulses bits can be counted to produced timers using CNT.

ON AND OFF DELAY TIMER

>>> TIMER

TIMER (TIM) widely used in industry to control a machine or equipment for a set period of time. It may consists of ON-delay or OFF-delay.

ON DELAY TIMER

·On- Delay Timer : This type of timer simply “Delay turning on”. In other words, after INPUT turns on we wait x-seconds before activating OUTPUT. This is the most common timer. It is often TON (timer On-delay), TIM (timer).

OFF DELAY TIMER

·Off-Delay Timer : This type of timer is the opposite of the on-delay timer listed above. This timer simply “Delay turning off”. After INPUT is on and turn on OUTPUT. When the INPUT is off, it hold the OUTPUT on for x-seconds before turning it off. It is called a TOF (timer off-delay) and is less common than the on-delay type listed above (i.e. few manufactures include this type of timer)

TIMER instruction requires TIMER numbers (XXXX), and set the value (SV) from 0000 to 9999 range (0 to 999.9 seconds).

PERIODS OF TIME IS SV X 0.1 SECONDS

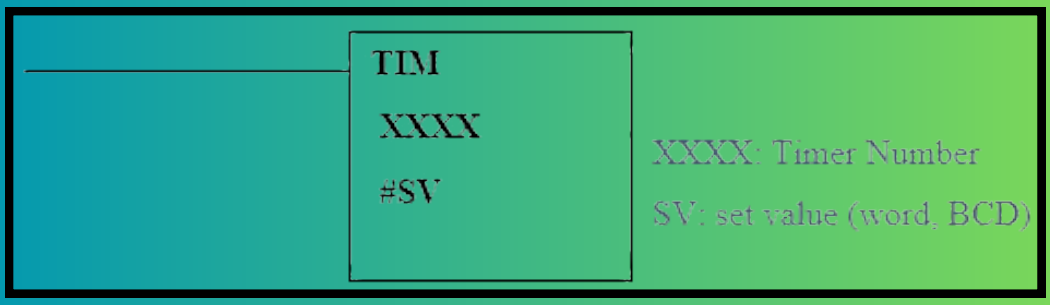


Figure 5.1: Timer set number

Note : Each number for TIM can be used as the definer for only one instruction of the TIMER

EXAMPLE 1
When a switch 0.00 is turned on, 5 sec later, OUTPUT 100.00 turn on and OUTPUT 100.01 turn off.

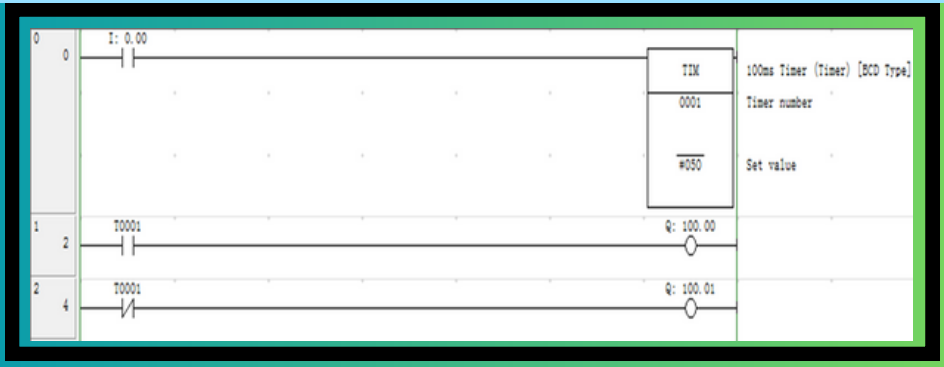
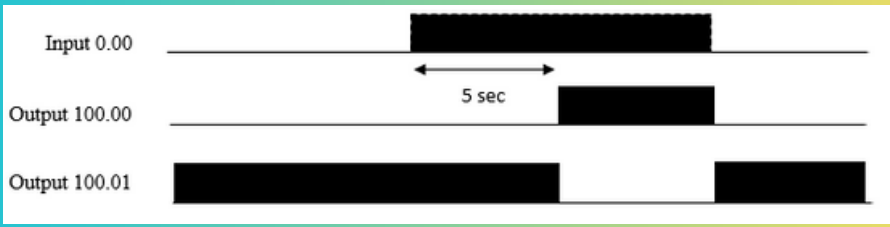


Figure 5.2: Timing diagram



INSTRUCTION LIST (MNEMONIC CODES)

Step	Instruction	Operand
0000	LD	0.00
0001	TIM	0001
		#050
0002	LD	T0001
0003	OUT	100.00
0004	LD NOT	T0001
0005	OUT	100.01
0006	END (01)	

EXAMPLE 2

When a switch 0.00 is turned on, TIMER 0000 and OUTPUT 100.01 will on for 4 sec then the timer will turn off OUTPUT 1001.

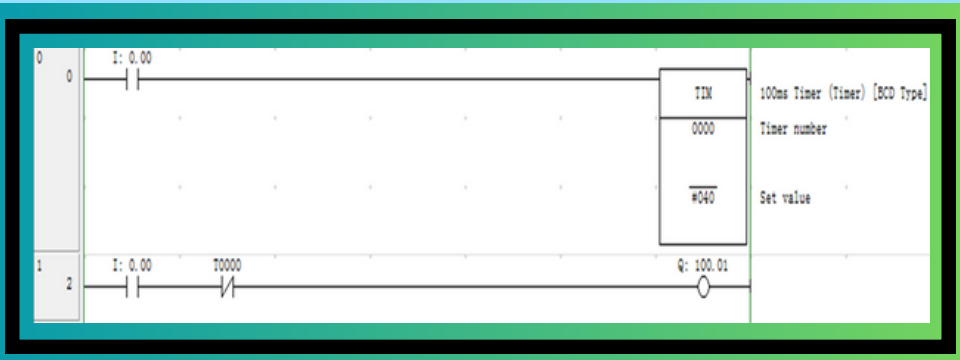


Figure 5.3: Timing diagram

INSTRUCTION LIST (MNEMONIC CODES)

Step	Instruction	Operand
0000	LD	0.00
0001	TIM	0000
		#040
0002	LD	0.00
0003	AND NOT	T0000
0004	OUT	100.01
0005	END (01)	

COUNTER

PLC

WHAT TO LEARN

1. EXPLAIN THE OPERATION OF A PLC COUNTER
2. DEVELOP SIMPLE PLC PROGRAM INVOLVING COUNTERS FOR INDUSTRIAL APPLICATION

FUNCTION

a) Counter is used for counting purposes. It can b set as a count-up or count-down.

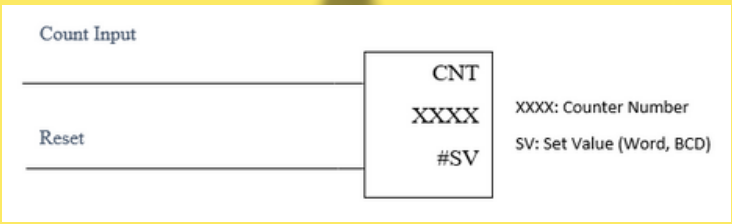
b)Each Counter number can be used as the definer in only one COUNTER Instruction.

c) CNT is used to count down from SV when the execution condition on the count pulses (CP) goes from OFF to ON, i.e, the present value (PV) will be decremented by one whenever CNT is executed with an ON execution condition for CP and the execution condition was OFF for the last execution. If the execution condition has not changed or has changed from ON to OFF, the PV of CNT will not be changed. The completion flag for a counter is turned ON when the PV reaches zero and will remain ON until the counter is reset.

d) CNT is reset with a reset input, R. When R goes from OFF to ON, the PV is reset to SV. The PV will not be decremented while R is ON. Counting down from SV will begin again when R goes OFF. The PV from CNT will not be reset in interlocked program sections or by power interrupts.

e) Program execution will continue even if a non-BCM SV is used, but the SV will not be correct.

INTRODUCTION



NOTE : THE COUNTER NUMBER MUST NOT BE DUPLICATED WITH THE TIMER NUMBER SINCE BOTH SHARE THE SAME DATA AREAS WITHIN THE PLC MEMORY.

Common application of COUNTERS include keeping track of the number of items moving past a given point, and determining the number of times a given action occurs. PLC counters can be designed to count up to a preset value or to count down to present value. The up-counter is incremented by 1 each time the rung containing the counter is energized. The down-counter decrements by 1 each time the rung containing the counter is energized.

EXAMPLE 1

Counter is set to 10 counts. When switch 0.00 is given a pulse of 10 counts, counter will be activated and OUTPUT 100.00 will be ON. When reset switch 0.01 is ON, counter will be back to its initial condition.

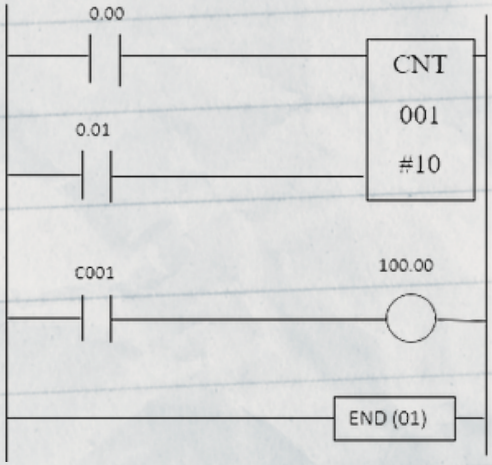
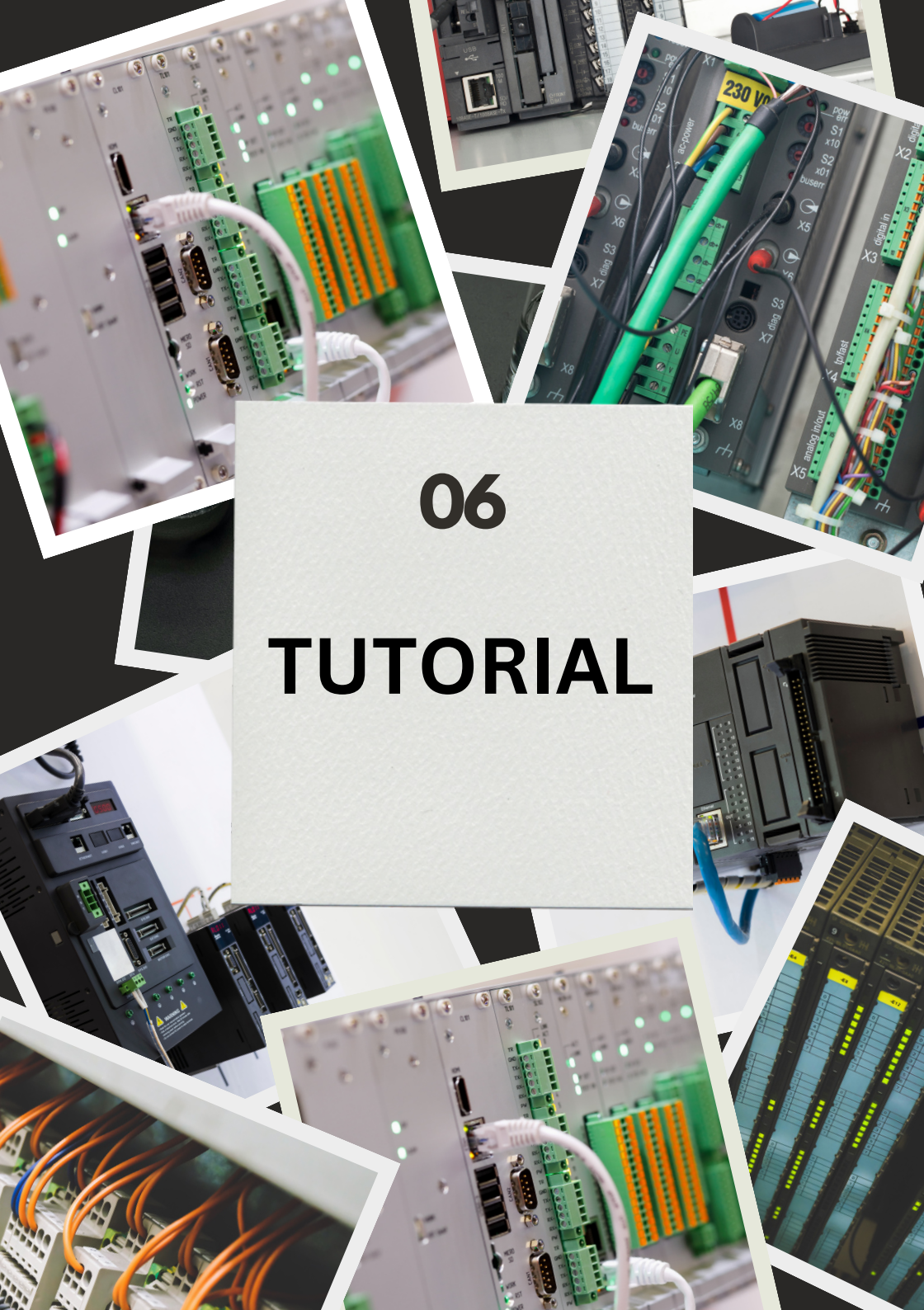


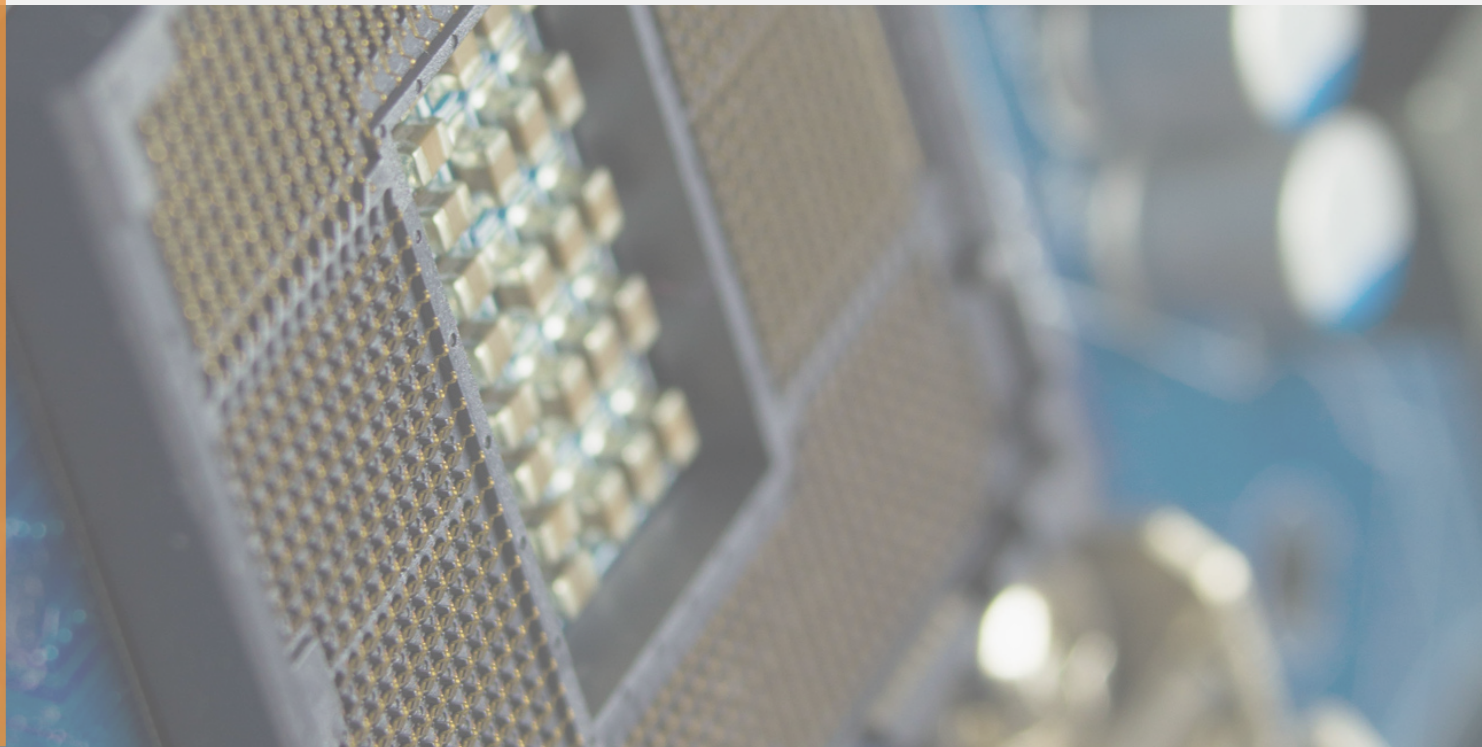
Figure 5.4: Counter diagram

INSTRUCTION LIST (MNEMONIC CODES

Step	Instruction	Operand
0000	LD	0.00
0001	LD	0.01
0002	CNT	001
		#0010
0003	LD	CNT001
0004	OUT	100.00
0005	END (01)	


06
TUTORIAL

06 TUTORIAL



TUTORIAL

EXERCISE 1

When a switch 0.01 is turned on, OUTPUT 100.01 goes on immediately and OUTPUT 100.02 goes on 9 sec later. Opening switch 0.01 turns both OUTPUT 100.01 and 100.02 off.

Draw a ladder diagram and mnemonic code for the above problems.

LADDER DIAGRAM MNEMONIC CODE

Step	Instruction	Operand	Step	Instruction	Operand
0000			0007		
0001			0008		
0002			0009		
0003			0010		
0004			0011		
0005			0012		
0006					

EXERCISE 2

Convert the ladder diagram to mnemonic code:

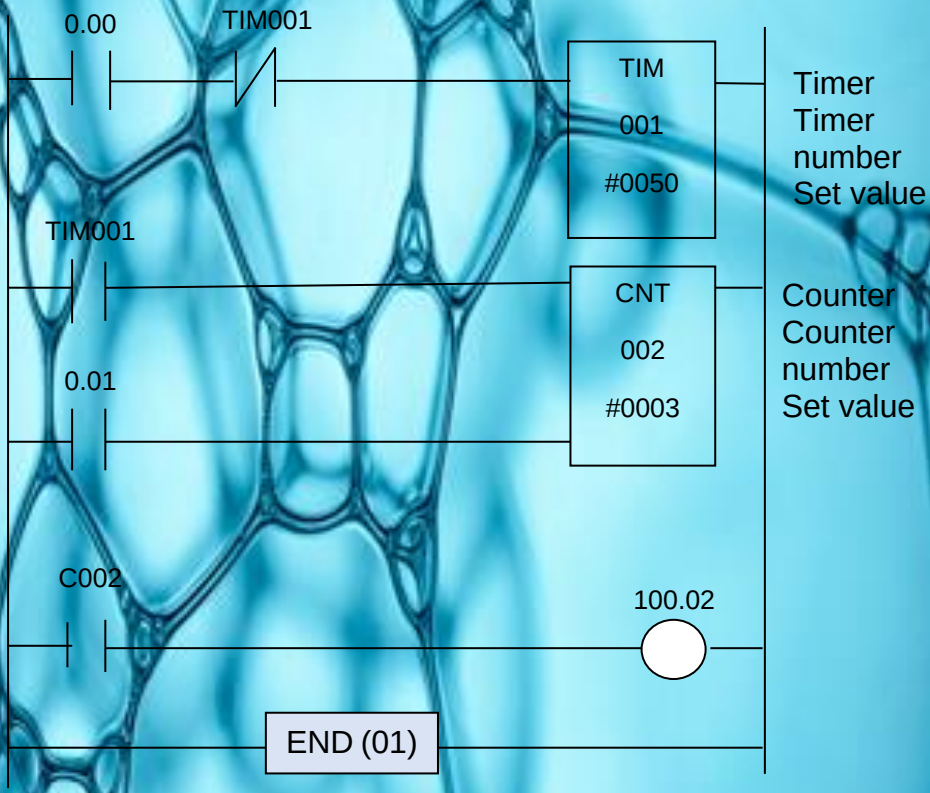


Figure 6.1

MNEMONIC CODE

Step	Instruction	Operand	Step	Instruction	Operand
0000			0006		
0001			0007		
0002			0008		

Step	Instruction	Operand	Step	Instruction	Operand
0003			0009		
0004			0010		
0005			0011		

EXERCISE 3

By drawing a ladder diagram and mnemonic code, solve the following problems, OUTPUT 100.00 will be ON when the switch 0.00 ON. When the switch 0.01 in the ON state by 5 times, OUTPUT 100.00 is OFF.

LADDER DIAGRAM MNEMONIC CODE

Step	Instruction	Operand
0000		
0001		
0002		
0003		
0004		
0005		
0006		
0007		
0008		
0009		

EXERCISE 4

OUTPUT 100.00 will be ON when the switch 0.01 ON for 5 times and will be OFF when the switch 0.02 ON for 3 times.

LADDER DIAGRAM MNEMONIC CODE

Step	Instruction	Operand
0000		
0001		
0002		
0003		
0004		
0005		
0006		
0007		
0008		
0009		
0010		
0011		
0012		
0013		
0014		
0015		
0016		
0017		

EXERCISE 5

A mobile traffic light is required for a road construction site. The traffic light is to be configures as a standard red – yellow – green pattern with the following “ON” times:

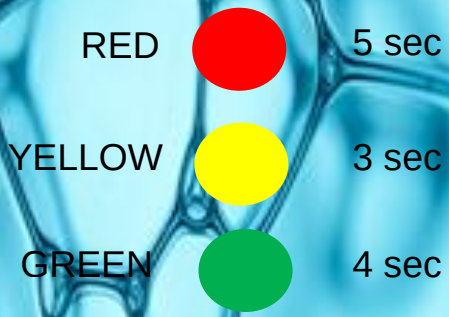


Figure 6.2

Push Button must be pressed to start the system. Stop Button use to stop the whole operation.

According to the above situation:

- List the input and output
- Write the ladder diagram
- Write the mnemonic code

EXERCISE 6

Figure 6.3 shown the automation system in factory. When PB1 (START Push Button) is pressed, box conveyor moves. Upon detection of box present, box conveyor stops and apple conveyor starts. Part sensors will count for 10 apples. Apple conveyor stops and box conveyor starts again. Counter will be reset and operation repeats until PB2 (STOP Push Button) is pressed.

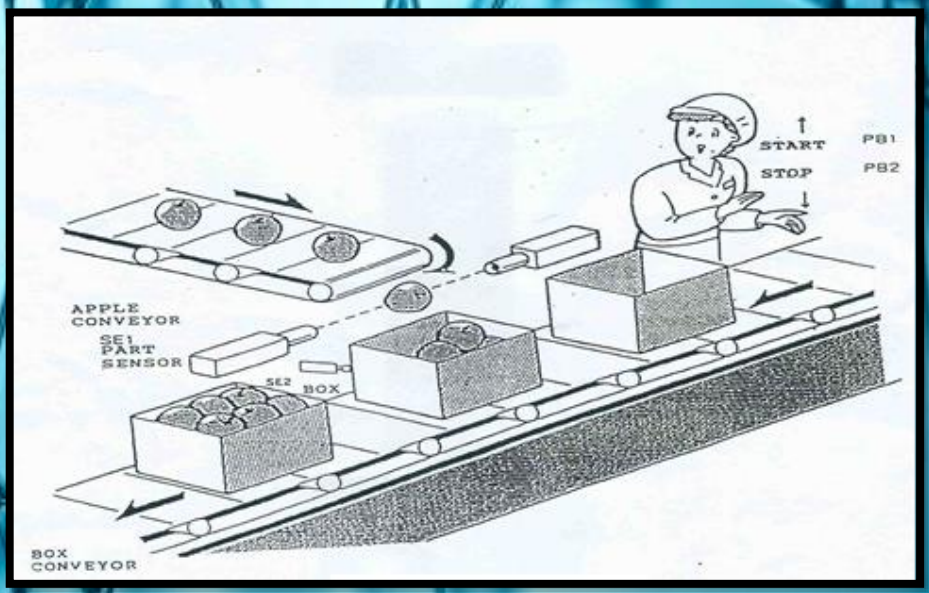


Figure 6.3

According to the above situation.

- List the input and output
- Write the ladder diagram
- Write the mnemonic code

EXERCISE 7

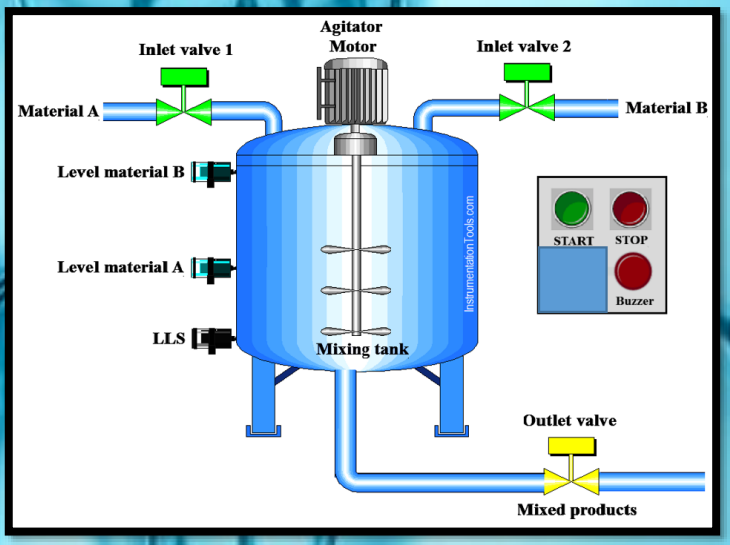


Figure 6.4

When the start button is pressed, the inlet valve 1 will open to allow material A to enter into the mixing tank. When the level material A sensor is active, the inlet valve 1 will be closed again. 3 seconds later, the inlet valve 2 will open to allow material B to enter into the mixing tank.

When level material B sensor is active, inlet valve 2 will be closed. 5 seconds later, the agitator motor will be active for 10 seconds.

Then, the outlet valve will open to allow the mixed products out to the next station. When the LLS sensor detect that mixed material has reached the bottom of the tank, the buzzer will sound until the stop button is pressed.

The entire system is also turned off when the stop button is pressed.

According to the above situation:

- List the input and output
- Write the ladder diagram
- Write the mnemonic code

EXERCISE 8

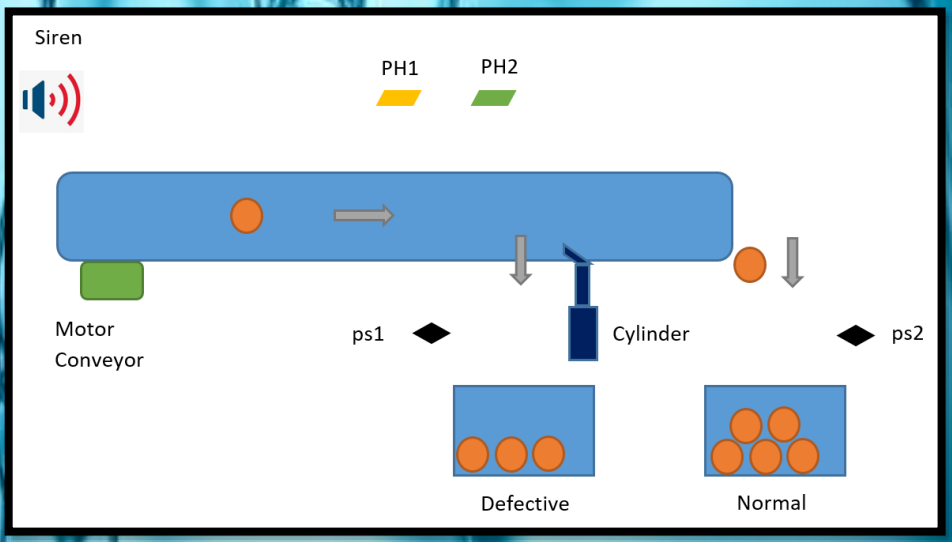


Figure 6.5

When Push Button is pressed, the conveyor moves to carry the product. Photoelectric sensor (PH1) works to detect defected products while Photoelectric sensor (PH2) works to detect normal products. If a defected product was

detected, the cylinder will extend to allow the defected product drop into the damaged product box. Otherwise, normal products drop into the normal product box.

The part sensor (ps1) and part sensor (ps2) work to detect the number of products entering the box respectively. If 5 defected products enter the box, the conveyor will stop, while 10 normal products enter the box, the conveyor will also stop. Sirens will sound on both of these conditions until the Stop Button is pressed to stop the entire operation.

According to the above situation:

-List the input and output

-Write the ladder diagram

-Write the mnemonic code

EXERCISE 9

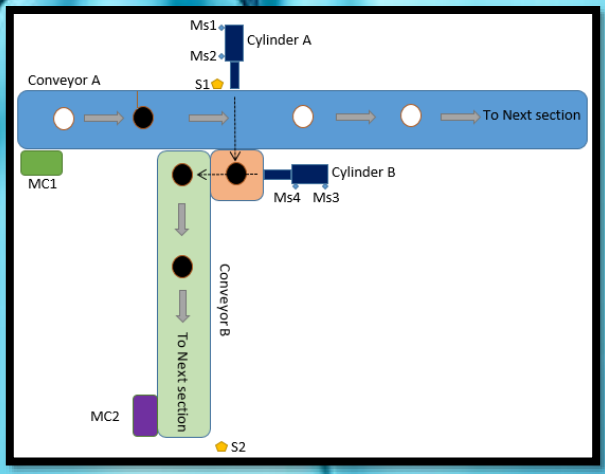


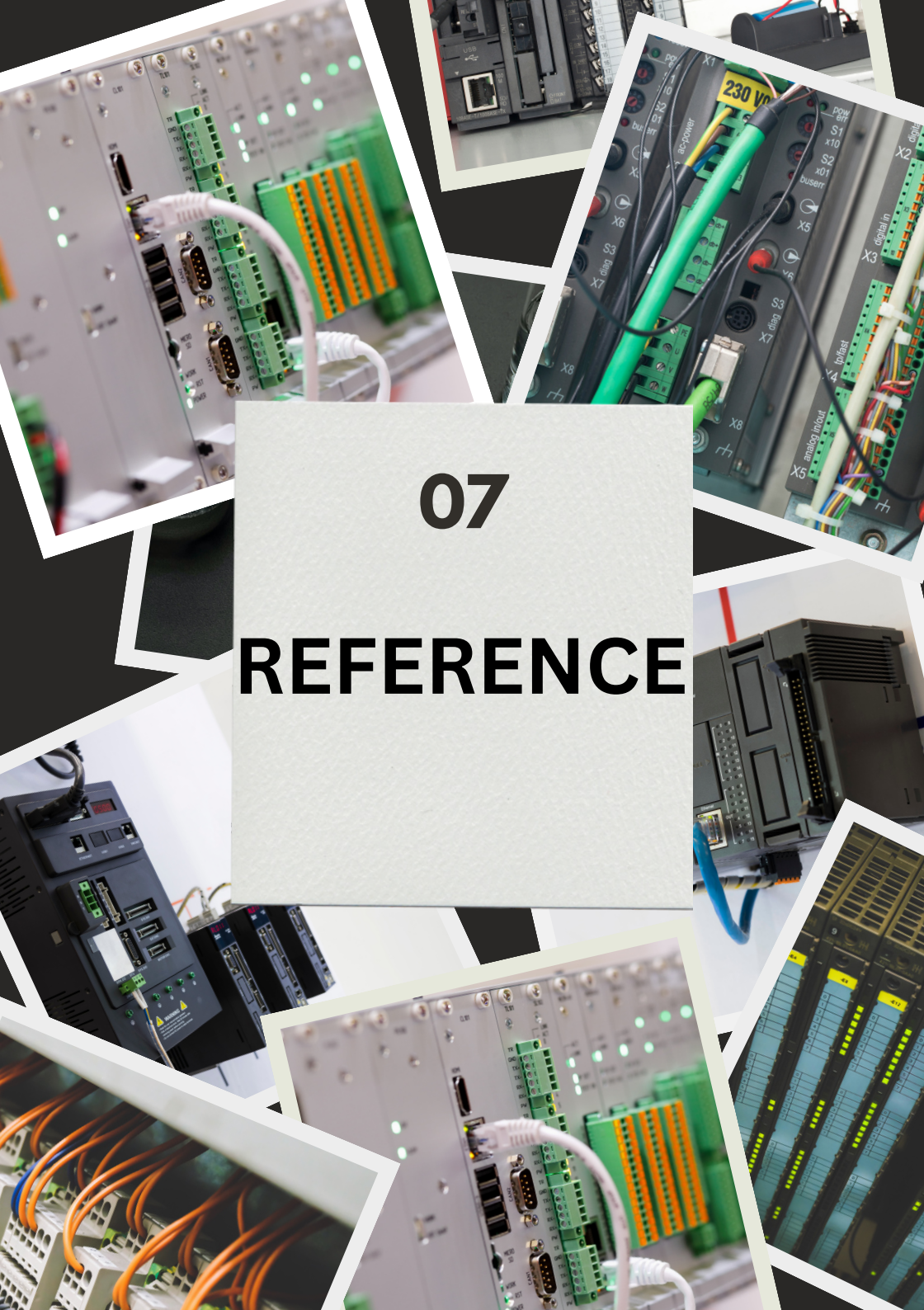
Figure 6.6

When push button is pressed, the motor conveyor MC1 will turn on the conveyor A to carries black material and white material. If the black material is detected by sensor S1, it will be changed to conveyor B while otherwise, the white material will go forward.

After 1 second sensor S1 was detected black material, the conveyor MC1 motor will stop, Cylinder A will extend to push the black material in front of Cylinder B. If Cylinder A is fully extended, Cylinder B will also extend to reject the black material onto conveyor B. When Cylinder B is fully extended, motor conveyor MC2 turn on the conveyor B. At the same time, cylinder A retract and follow by cylinder B. If cylinder B is fully retracted, conveyor A will function again. Conveyor B turn off when sensor S2 was energized. Stop button serves to stop the whole operation.

According to the above situation:

- List the input and output
- Write the ladder diagram
- Write the mnemonic code



07

REFERENCE

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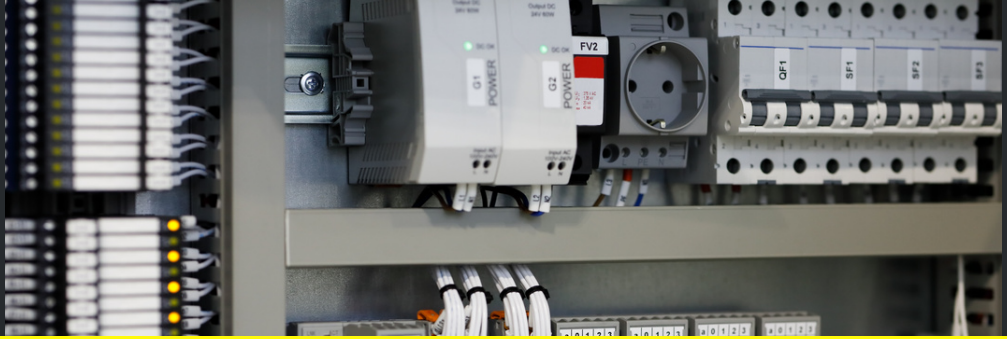

Fast and Easy Revision Programmable Logic Controller are published as a simple guide for students and teachers, especially in the Department of Polytechnic Education. The most basic concepts in Programmable Logic Controller are given along with exercises to reinforce student understanding.

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